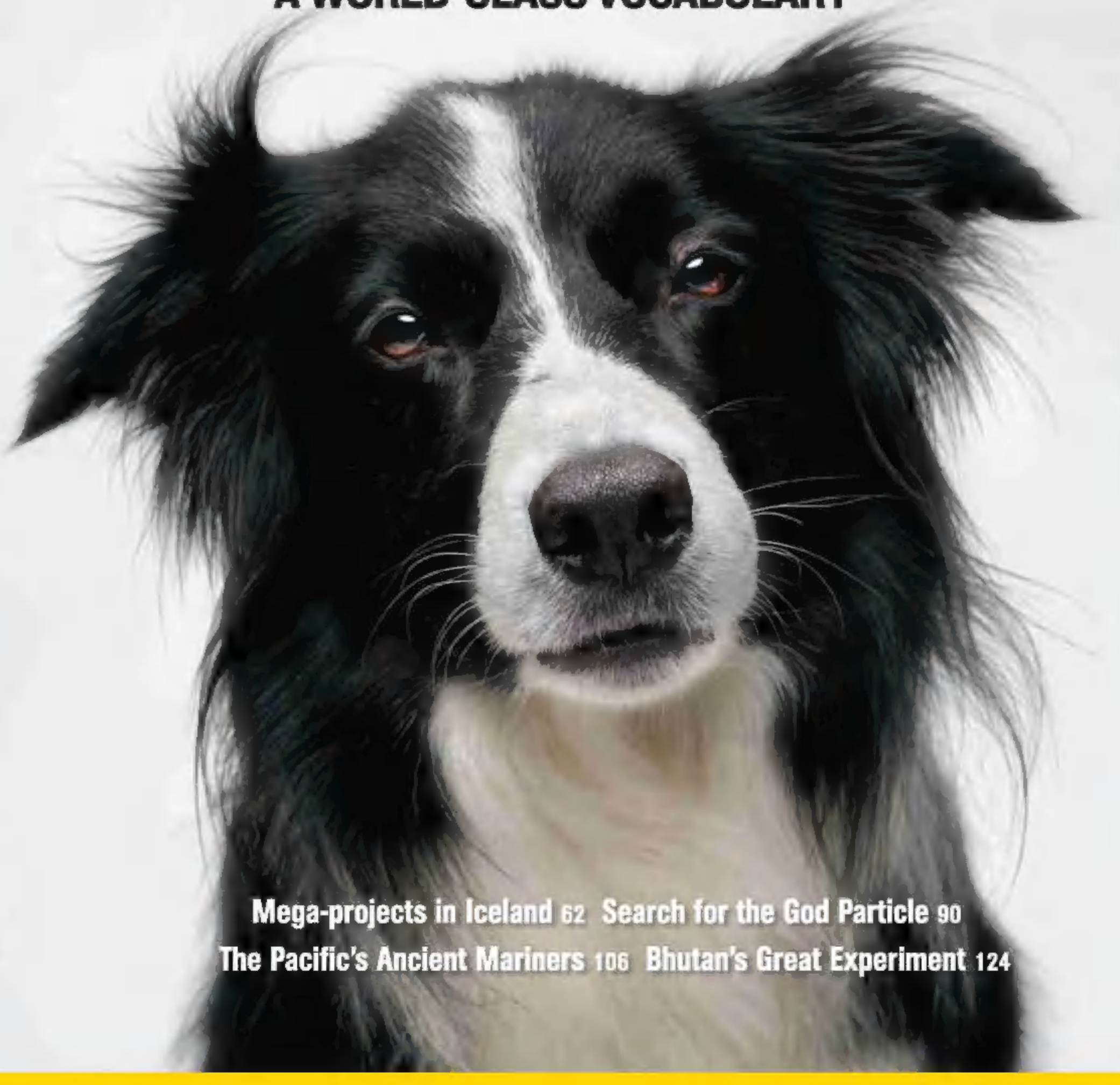
NATIONALGEOGRAPHIC.COM/MAGAZINE | MARCH 2008

NATIONAL GEOGRAPHIC

Inside Animal Minds

BIRDS, APES, DOLPHINS, AND A DOG WITH A WORLD-CLASS VOCABULARY



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Barbara Banke, Alexander Mountain Estate, Alexander Valley

KENDALL-JACKSON

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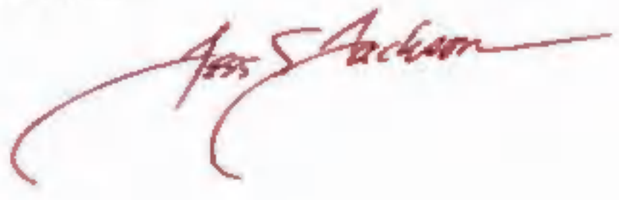

kj.com/truth

NATIONAL GEOGRAPHIC

MARCH 2008 · VOL. 213 · NO. 3

LYNSEY ADDARIO

Monks-in-training in Bhutan take a break from studies—and may even whip out cell phones hidden in their robes. Many families in the Buddhist nation believe sending a young son to a monastery brings good karma. Story on page 124.

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Brainy fellow creatures show that humans are not alone in their ability to invent, plan, or contemplate.
BY VIRGINIA MORELL PHOTOGRAPHS BY VINCENT J. MUSI

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Close-knit Icelanders are proud of their beautiful country. But now they face a divisive challenge of protecting the environment while expanding the economy.
BY MARGUERITE DEL GIUDICE PHOTOGRAPHS BY JONAS BENDIKSEN

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Physicists have high hopes for Europe's giant new atom smasher—they want nothing less than to crack the code of the physical universe.
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An important archaeological find is helping experts piece together an enduring puzzle: how voyagers in simple canoes managed to colonize the vast Pacific's island outposts.
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A Himalayan kingdom trades poverty and isolation for GNH—Gross National Happiness—and a daring move to democracy.
BY BROOK LARMER PHOTOGRAPHS BY LYNSEY ADDARIO

COVER "Betsy" is one smart border collie. She understands 340 words, and she'll pose for a portrait without bribery. **PHOTO BY VINCENT J. MUSI**

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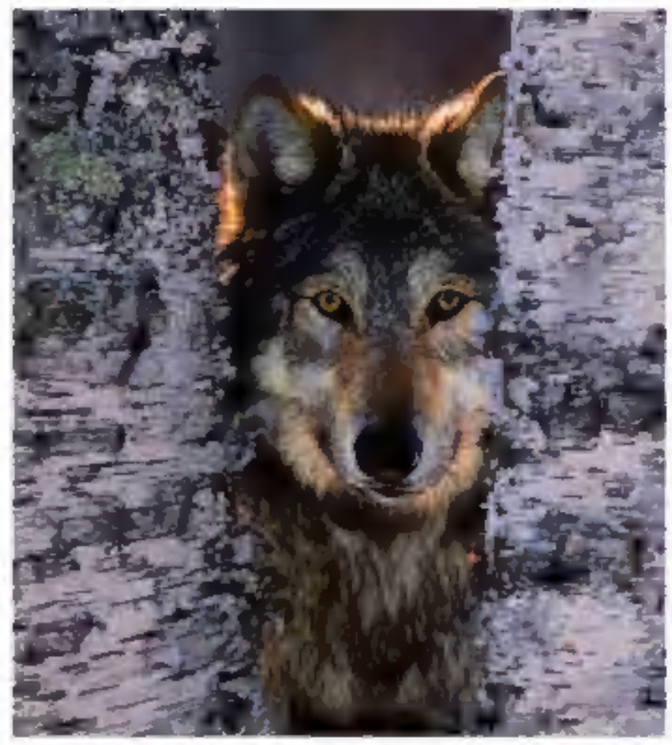
Bound by Rings

Wisdom Teeth



No Longer Endangered

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West Nile Virus Takes Wing
Grand Canyon Skywalk

On the Web

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Pacific Pathways
Listen to experts explain how ancient seafarers sailed across Earth's biggest ocean, and trace the waves of migration on an interactive map.

Keeping Up With the Climate
The latest reports from *Climate Connections*, an ongoing collaboration between National Geographic and NPR, are posted at *ngm.com/climateconnections* and *npr.org/climateconnections*.

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EDITOR'S NOTE

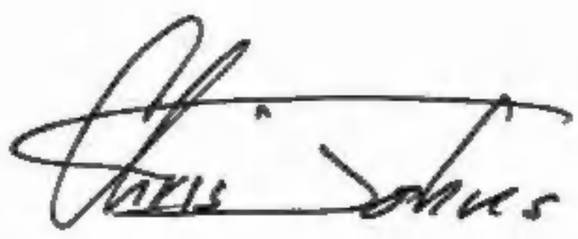
Chaos reigns in the elephant herd. African wild dogs are everywhere—darting between gigantic legs, spinning in circles, leaping to nip tails. The dogs clearly enjoy the moment of play.

It seemed like a normal hunt in search of an impala dinner when the wild dogs in Botswana's Okavango Delta started out that afternoon. Then they bumped into the herd. I understand why the elephants were upset, but why would the dogs behave in a way that has nothing to do with feeding the pack? Their behavior probably scared away every impala in the area. What were they thinking?

African wild dog pups play with a strip of impala hide.

This month's cover story, "Minds of Their Own," explores what animals—wild and domesticated—are thinking. Virginia Morell writes about a border collie with a vocabulary of over 300 words. I'm not surprised. My own border collie, Millie, opens doors, gets into cabinets, herds the family, and when she feels like it, follows my commands. Then there's our cockatiel, Minnie Pearl, who imitates the telephone (we frantically run to answer it) and sings an alert when visitors turn into our driveway, a quarter mile away.

Our article is not a prescription for getting your pets to behave, but it does offer insight into animal intelligence. The more we learn about how animals think, the more we learn about ourselves. If you don't believe me, ask Millie.

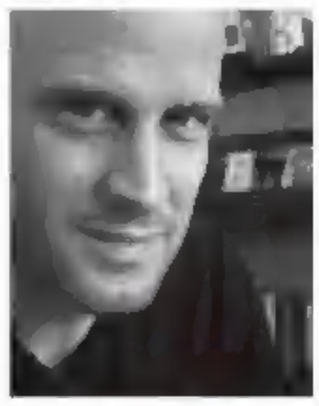


PEOPLE BEHIND THE STORIES

■ **Joel Achenbach** Reporting on the Large Hadron Collider, the writer says, "I drove on winding roads through tiny

French and Swiss villages, amid fields of sunflowers and farms that look straight out of the 18th century. It's all very pastoral, except for the huge atom smasher somewhere deep below. I kept a map unfolded while I tried to figure out when I was directly over the LHC tunnel. Finally I got to Crozet, where my map told me that the tunnel was beneath two stone watering troughs, which were probably slaking the thirst of horses back in the days of Voltaire. So that's where my story begins."

■ **Brook Larmer** Before he wrote "Bhutan's Enlightened Experiment," Larmer already had a sense of the kingdom's magic. In 2006 he and his wife, Hannah,



trekked to Chimi Lhakhang, a Buddhist temple renowned for its fertility blessings. The couple wasn't looking for such help, but on a whim, Hannah bowed her head and was blessed by the head monk, Sangay Dorji. "When I returned to Bhutan nine months later," says Larmer, "I had news for Sangay Dorji: Hannah was pregnant. Our son was born in 2007, and a part of us will always believe that his inspiration originated in Bhutan, a land that manages to maintain a balance between the earthy and the mystical."

PHOTOS (CLOCKWISE FROM LEFT): CHRIS JOHNS, NG; REBECCA HALE, NG STAFF; HANNAH BEECH

Yellow-eyed Leaf Frog *(Agalychnis annae)*
Size: Head and body length, 57 - 84 mm (2.2 - 3.3 inches) **Weight:** 10 - 20 g (0.4 - 0.7 oz.)
Habitat: With the disappearance of its preferred montane, moist and wet rainforest, it is now found in plantations and gardens **Surviving number:** Unknown; populations declining

Photographed by Gregory Basco

WILDLIFE AS CANON SEES IT

Wor-or-op! This single-note call—repeated every 40 seconds to several minutes—used to be a daily part of the rainforest's soundtrack. Now, with the virtual disappearance of its former forest home, the male yellow-eyed leaf frog's rainy season calls are vanishing. So far, the amphibian has found ways to survive in its new plantation and urban environments; these days, tadpoles are as likely to be found in swimming pools and garden fountains as in ponds. Being an opportunistic feeder also helps in its struggle to stay alive. Yet the very serious threats the frog faces include not only dramatic habitat loss, but also pollution and disease. Consider it a call for help.

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PRESIDENT'S NOTE

NGS President John Fahey takes to his kayak to enjoy the great—and green—outdoors.

Suddenly everyone is going green, or so it seems. For many, it's a new concept, but at the National Geographic Society we've embraced values now considered green since our founding in 1888. We pay attention to all the ways, big and small, in which we can be responsible citizens of the planet. Our Washington, D.C., headquarters was the first existing building in the U.S. to earn the silver level in the Leadership in Energy and Environmental Design Green Building Rating System. We buy wind-energy credits to account for 100 percent of our electric power. Most of our lighting comes from energy-efficient fluorescent tubes and bulbs. We recycle, and we have introduced composting in our cafeteria. And to produce this magazine, we've chosen paper mills that use environmentally sound means of production. But being green is a constant challenge. We struggle with the same issues as other organizations. How can we best offset fuel use when work involves travel? Should we stop selling plastic water bottles in our cafeteria?

Last year we acquired the *Green Guide (thegreenguide.com)*, a consumer resource for Earth-friendly living, offering useful perspectives more sophisticated than "paper or plastic." We've found that the *Green Guide* has enriched our awareness of how each of us can make a difference. What businesses and individuals do really matters.

National Geographic is not an advocacy organization. We report on science and believe in facts and common sense. We'll continue to cover, carefully and objectively, the issues that have an impact on our environment. As our National Geographic Channel campaign suggests, we must "Preserve Our Planet." Being green is not a trend. It is, perhaps, the most important challenge of our time.

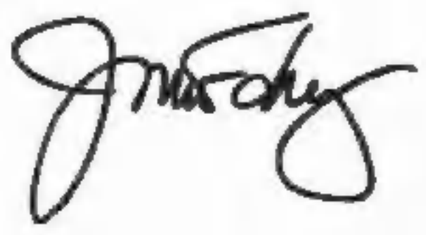

PHOTO: NATIONAL GEOGRAPHIC PHOTOGRAPHER MARK THIESSEN

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NATIONAL GEOGRAPHIC

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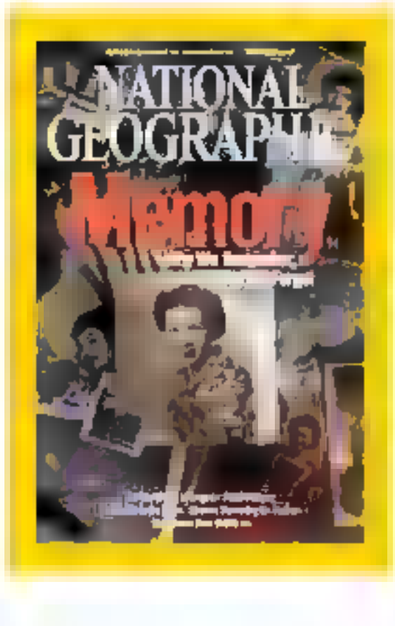
LETTERS



November 2007 *This month brought much praise for "Hunters: For Love of the Land." But not all readers were pleased. "I have no respect for hunters who kill just to kill, don't eat what they kill, leave lead and trash in the environment, and do nothing but complain about the cost of it all," wrote Karen Benzel of Carmel, California. "The real cost is never talked about."*

Comment on March stories at **ngm.com.**

Hunters: For Love of the Land

As a woman in my 30s who is an avid hunter, I am often looked upon as an oddity. I gained a love of hunting from family—mother and grandmother included! Now my husband and son join us on these family trips. Thank you for an excellent article. Too often hunters are represented as bloodthirsty killers by the so-called environmentalist movement. If you look at the facts, you will see that hunters put far more time and money into preservation of land and animals than any other group.

LAURA GRIFFITH
Custer, Washington

I have been hunting for 40-odd years. I live in rural Virginia in the area around Lynchburg. We are constantly losing land to new housing developments. I have seen the lands on which I grew up hunting slowly shrink away. There are only a few that I can now hunt on; the rest have houses built on them. The habitat for wildlife has also suffered from the building. Once bobwhite quail could be found almost anywhere. Their calls in the spring and summer were always enjoyed by those who got out in the fields and forests, but now I cannot remember the last time I heard them calling. This is truly a loss. There are national forest lands close by where I can hunt, but I still miss being able to go out on an autumn morning and stop at some farmer's house and get permission to hunt his land—and just talk with him as a neighbor for ■ while.

JOHNNY LEE WITT
Evington, Virginia

I was pleasantly surprised by the well-balanced article concerning hunting. However I take issue with two points that were made. People who poach or leave a wounded animal to suffer shouldn't be called hunters. They are poachers. The other is the issue of people like Ted Turner who buy tracts of land and lock out the average hunter. The wealthy who go from area to area each fall to kill animals only for the heads are one of the major reasons that hunter numbers are dropping nationwide. The meat hunter will soon be a thing of the past if this continues.

CHUCK MISCHKE
Worland, Wyoming

"Save an elk, shoot a wolf." This is a favorite slogan of hunters where both of these animals can be found. It demonstrates what author Robert Poole artfully sidesteps: By and large, hunters protect nature when it is in their interest. While the habitat that hunters have protected is invaluable, it is absurd to commend them for their efforts when the result is ■ side effect of a selfish pursuit. Poole seduces readers with his romantic description of ethical hunters into thinking that this is what nature intended. On the contrary, hunting for sport is despicable, hunting for food is usually unnecessary, and conserving habitat to kill the inhabitants reflects a second-rate land ethic.

JOHN SHACKELFORD
Eagle, Idaho

Thank you for speaking up for the silent majority of hunters in this country who are naturalists at heart. Hunting is conserving open space for everyone to enjoy. Without it wildlife management programs and habitat reclamation projects would never get funded. Unfortunately, fair chase hunters like me are being overshadowed by poachers, trophy hunters, "gun nuts," and sadistic ranchers who guarantee a kill for the right price. Hunting will continue to be socially unacceptable and misunderstood until more articles like yours reach the masses.

DWAYNE D. BEYNON
Port Deposit, Maryland

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LETTERS

While many loudly profess their fondness for wildlife, hunters are among the few willing to foot the bill. In my home state of Colorado the sale of hunting and fishing licenses, combined with federal allocation of taxes collected on hunting products, accounts for approximately 85 percent of the total annual budget of our Division of Wildlife. This funds all wildlife-related projects and research—even so far as compensating ■ landowner should a herd of elk demolish a fence. The excellent health and numbers of Colorado's wildlife cost the taxpayer nothing. Many times I have come home empty-handed from a hunting trip, still satisfied that the money I spent will benefit the animals that roam the woods and soar in the skies. Sadly, though, there is nowhere a wild creature can hide from the inexorable march of shopping centers, housing developments, and concrete. If no wildlife remains for future generations to enjoy, it will not be due to rifle bullets or shotgun shells.

TOM BULLOCH
Woodland Park, Colorado

While I'm sure that you will hear a howl from a small but vocal minority decrying the glorification of blood sport, I would like to commend you for producing a piece that shows all the hard work that goes into conserving the land and values that protect our nation's wildlife. When my family sits down to a venison meal, we give thanks to the animal that provided it. How many think twice about the hamburger or chicken breast that they consume?

JIM HUSTED
Bremerton, Washington

I was so shocked and dismayed when I picked up this month's issue glamorizing the barbaric practice of hunting that I had to check to make sure the year was indeed 2007, not 1957 or, for that matter, 1907. There is simply no excuse for hunting. If you want the thrill of pursuit, become a bird-watcher or a wildlife photographer and stalk your prey with a camera. If you want to eat exotic meat, everything from alligator to zebra is available through farming, where animals are slaughtered not for sport but out of necessity. If you like guns that much,

go to a firing range. And if you really must engage in destructive violence for a sport, man up and take on a fellow human in a boxing ring or a karate dojo. Hunting is killing for pleasure. It is pathetic, sick, and cruel.

ADAM DORR
Ann Arbor, Michigan

I live in an area where this "sport" abounds, and it is sickening the way these "men" (I use the term loosely) strut about with a can of beer in one hand and a gun in the other. I have been behind trucks loaded with deer carcasses. I have seen wounded deer (thanks to either poor shots or half-witted bow hunters) struggling through the brush. Don't insult my intelligence by saying these people are interested in conservation. The only thing they care about is that rack of antlers hanging on their den wall to brag about to their beer-guzzling friends. They neglect and abuse their dogs, hence the overload of (starving) beagles at the shelter. Animal lovers? I don't think so.

BETTY HOFAWGER
Sterling, Virginia

Years ago when people hunted for survival, it was a different matter. Nowadays hunting for so-called sport is an abomination. It belittles the wondrous nature of your magazine to glorify the killing of innocent wildlife.

JEAN BIRD
Leicester, England

Remember This

My observations during 40-plus years as a psychotherapist have led to my own notions about memory. My theory is that we do not store stimuli, we only store our responses to stimulus. From age zero and even earlier, we are bombarded with stimuli, so that we constantly respond. We store these responses, and they become our subconscious. The stimuli get stored as memories only on the conscious level. The task of psychoanalysis is to help bring the subconscious responses into consciousness, where we are able to take charge of them. As long as they remain in the subconscious, they are in charge of us.

PAUL HEBER
St. Augustine, Florida

Death Valley

Tim Cahill's excellent article describes the mechanism for moving rocks around the mud of a "dry" lake bed. He is mostly right, but the real explanation is much more simple and easy to believe. The same winter storms create a shallow lake, inches deep, which then freezes. The rocks are held in huge plates of floating ice—which provide plenty of surface area for the wind to grab on to and move the rocks.

MICHAEL BROWN
Boulder, Colorado

Researchers once suspected that winds moved the Racetrack's rocks while the stones were frozen in plates of desert-floor ice. But more recent studies show that several of the rock tracks don't fit the ice floe hypothesis. Ice may play a minor role, but these studies make a strong case that wind alone is sufficient to move the rocks.

Tonga: While the King Sleeps

His Majesty King George V (KGV) is one of the kindest, brightest, and most gentle persons I have ever had the privilege to know. He is also a person with the daunting job of leading his people from a thousand years of rich tradition to meet the inevitable and pervasive onslaught of western-ization currently overtaking his country in a sometimes not-so-gentle manner. KGV is targeting building a strong economy in one of the smallest countries in the world, which is also one of the most resource-poor countries in the world. With regard to the democratization of this ancient and tradition-rich kingdom, KGV is ensuring it will come at a Tonga-appropriate pace. KGV has already revolutionized the political system by appointing the current prime minister and a number of key cabinet members and government department heads from commoners and people's representatives, not the bloodline nobility as was the ancient tradition. Such action would not even have been thinkable a couple of decades ago. Democracy may not even be appropriate in Tonga. But this is for its people to decide. And in a relatively short period of time, they will.

RICHARD STOLL
Poulsbo, Washington

The men urged us all to drink kava with them, and I can assure you that it was the bitterest, most unappealing liquid that I have ever sampled. One sip was all that anyone in my group could endure.

The account of Teague's visit with the villagers of Houma on the island of Tongatapu, Tonga, contained a graphic description of the men heavily imbibing kava, the local narcotic drink, during their meeting. A few years ago, my tour group on the island of Fiji had a similar experience at a meeting of local villagers. The men urged us all to drink kava with them, and I can assure you that it was the bitterest, most unappealing liquid that I have ever sampled. One sip was all that anyone in my group could endure. Teague's ability to keep drinking with his hosts demonstrated a strong social grace.

BERNIE SINGER
The Villages, Florida

I was ■ Peace Corps volunteer in Tonga in the early 1990s and am married to a Tongan woman. I was surprised that the article did not mention Professor Futa Helu, the founder and head of 'Atenisi University and one of the leading proponents of democracy in the kingdom. While I was in my Peace Corps training, a democracy convention took place at the Catholic basilica in Nuku'alofa, and Futa Helu invited us to attend. However, we had received instruction not to go, as Peace Corps volunteers must stay out of political affairs.

DONALD E. THOMAS
Concord, California

Author Matthew Teague gives a distorted picture of Tonga. There is ■ 99 percent literacy rate (by Teague's own admission). What other country can say that? It is quite obvious that Teague started his interview of the prince with a hostile attitude, which the prince quickly detected and so terminated the interview. King George V (the prince at the time of Teague's interview) may not be the king of kings, but bringing a slumbering country into some of the aspects of the modern era is ■ formidable task. What an injustice this article does to a beautiful country and its new king.

LEONORE LEVIT
Wilmette, Illinois

How can disease be detected before it strikes?

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Jeremiah Ridgeway Fort Drum, New York

Stationed in Afghanistan for 16 months, Jeremiah Ridgeway, 25—a specialist with the U.S. Army—kept his camera close. He made this photo in the village of Kamdesh. "The soldier pictured is a regular in the Afghan National Army," says Ridgeway.

Bob Miller Lynchburg, Virginia

"I was traveling the back roads of Thomas Jefferson National Forest," says Bob Miller, 57. "Suddenly the light broke through the mist." Miller's picture was the Your Shot website's top vote-getter for the month.

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Romani faithful march into Mediterranean surf to honor their patron saint, St. Sara.

More of Paris-based Nigel Dickinson's work on the Romanis of Europe can be found on his website, nigeldickinson.com.

Befriended by Romanis When I first went to the great pilgrim festival at Les-Saintes-Maries-de-la-Mer in 1993, I had no idea I was beginning a project that would consume nearly 15 years of my life. Each May thousands of Romani families from all over France and across Europe gather in this small coastal town. It's a religious event, where relics and statues of saints are venerated, but it's also ■ reunion and ■ celebration, where babies are baptized, marriages arranged, traditions passed on. In 2001 José La Fleur marched to the sea with a banner (above) that his father, Pepe, carried for many years before him. Surrounded by Gypsies (I later learned that "Gypsy" is considered a derogatory word, and few Romanis use it to describe themselves), I was drawn to their world.

I discovered Europe holds many Romani worlds. In England's Midlands I rode 20 to 30 miles a day in traditional—and rare, now—horse caravans. In the former Yugoslav republics I encountered doctors and engineers, well-educated professionals turned struggling refugees from Kosovo's ethnic violence. From Turkey to Finland I was treated graciously in prosperous homes and in desperate slums.

I go back to Les-Saintes-Maries-de-la-Mer every year. I stood in the church there with a candle in my hand instead of a camera for the baptism of my Romani godchild. This project has given me great friends all over Europe, and I hope it will help others look at Romanis and see people—not exotic or threatening outsiders, but people who work, and love, and struggle, just as we all do.

FOUNDATION FOR INNOVATIVE NEW DIAGNOSTICS

About 1.6 million people die of tuberculosis (TB) each year[1] mostly in developing nations lacking access to fast, accurate testing technology.

TB is the current focus of the Foundation for Innovative New Diagnostics (FIND), established with funding from the Bill and Melinda Gates Foundation. FIND is dedicated to the advancement of diagnostic testing for infectious diseases in developing countries. For more information, visit www.finddiagnostics.org.

A young girl reveals hope in India, which carries one-third of the global burden of TB.

BD

Helping all people live healthy lives

Partnering against TB

Twenty-two developing countries carry the burden of 80 percent of the world's cases of TB, the second-leading killer among infectious diseases and primary cause of death among people with HIV/AIDS. The problem is compounded by TB's resistance to drug treatment, limiting the options for over 450,000 patients annually.

BD is pleased to work with FIND to provide equipment, reagents, training and support to the public health sector in high-burdened countries on terms that will enable them to purchase and implement these on a sustainable basis.

The BD MGIT™ (Mycobacteria Growth Indicator Tube) system can shorten the recovery of TB in culture from 42 days to as little as 10-14 days. In addition, by identifying resistance to specific drugs, the BD MGIT system provides fast and reliable information that can help physicians prescribe more effective treatments. All this can contribute to the reduction in spread and mortality of TB, particularly in the HIV/AIDS population, where it is especially difficult to diagnose.

Named one of *America's Most Admired Companies*[2] as well as one of the *World's Most Ethical Companies,*[3] BD provides advanced medical technology to serve the global community's greatest needs.

BD – *Helping all people live healthy lives.*

[1] Source of all statistics cited: StopTB/World Health Organization, 2007.
[2] *FORTUNE*, March 19, 2007
[3] *Ethisphere™ Magazine*, April 2007

Please visit www.bd.com

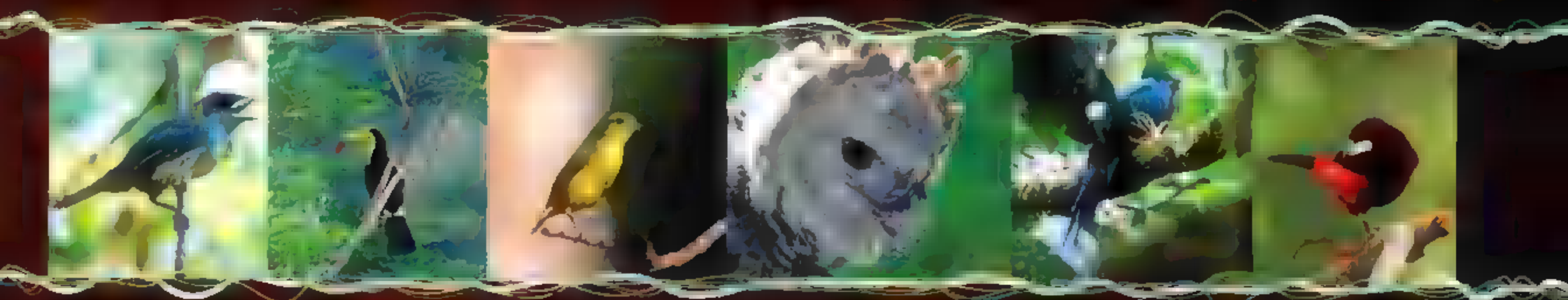
TB ANYWHERE IS EVERYWHERE | World TB Day March 24, 2008

Their houses immaculate, the voluminous skirts that anchor their wardrobes topped by lavishly embellished blouses, Romani women in Helsinki celebrate Mother's Day with tea and cakes. Among Finland's estimated 10,000 Romanis, there is "pride in being Finnish," Dickinson says, "but also determination to preserve their own traditions."

With a bare-chested display of body art and cultural flexibility, Serbian Romanis gather in a Belgrade home for a Christmas feast that includes chicken for Muslim family members and pork for Orthodox Christians. The abundance of the holiday table signifies the well-being that hosts and guests all hope to share in the new year.

"By far the most populous drive-thru of the Americas"
According to 973 spotted bird species.

30,193. sq. miles of rich biodiversity and vast forest.
No wonder it is a bird's favorite place to stay in.



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In the summer of 1999 Dickinson met a Romani mother—barely more than a child herself—in Montenegro. Her family had fled the ethnic cleansing that wracked Kosovo. "They had no official refugee status and couldn't afford the 'Mafia boat' to Italy," Dickinson says. "All they could do was wait."

It's not just the flagship of a company, but of an entire industry.

THE 2008 S-CLASS.

While we don't claim to predict the future, we can tell you with some degree of confidence what automakers will be doing in the years to come. We say this not as a matter of mere speculation, but from firsthand experience.

For decades, the S-Class Sedan has been the platinum standard of luxury, craftsmanship and engineering innovation, and the inspiration for many of the industry's most meaningful and important advancements.

Yet its leadership role is not merely a product of its unequaled technological prowess. Since its inception, the car's striking presence has been an S-Class trademark. The current model is a perfect example—subtle in design and undeniably commanding in scale. Yet this imposing automobile performs with agility and grace that is nothing less than breathtaking.

An S 550 will carry its occupants in luxury from 0 to 60 mph in just 5.4 seconds.* (An AMG variant of the same car will do it in 4.5 seconds.) And on the German autobahn, this car can cruise in excess of 135 mph.**

The sense of complete serenity at these speeds, or any speed, is yet another facet of its flagship character. And the one which other makers find most difficult to duplicate.

As the 2008 S-Class rolls out of the factory in Stuttgart, it will undoubtedly capture the hearts of the pundits. World governments, sports heroes and business moguls will make their purchases. But few will pay closer attention than the people who build other cars.

THE S-CLASS. *The sedan that set the standard for advanced automobile engineering and continues to raise it.*

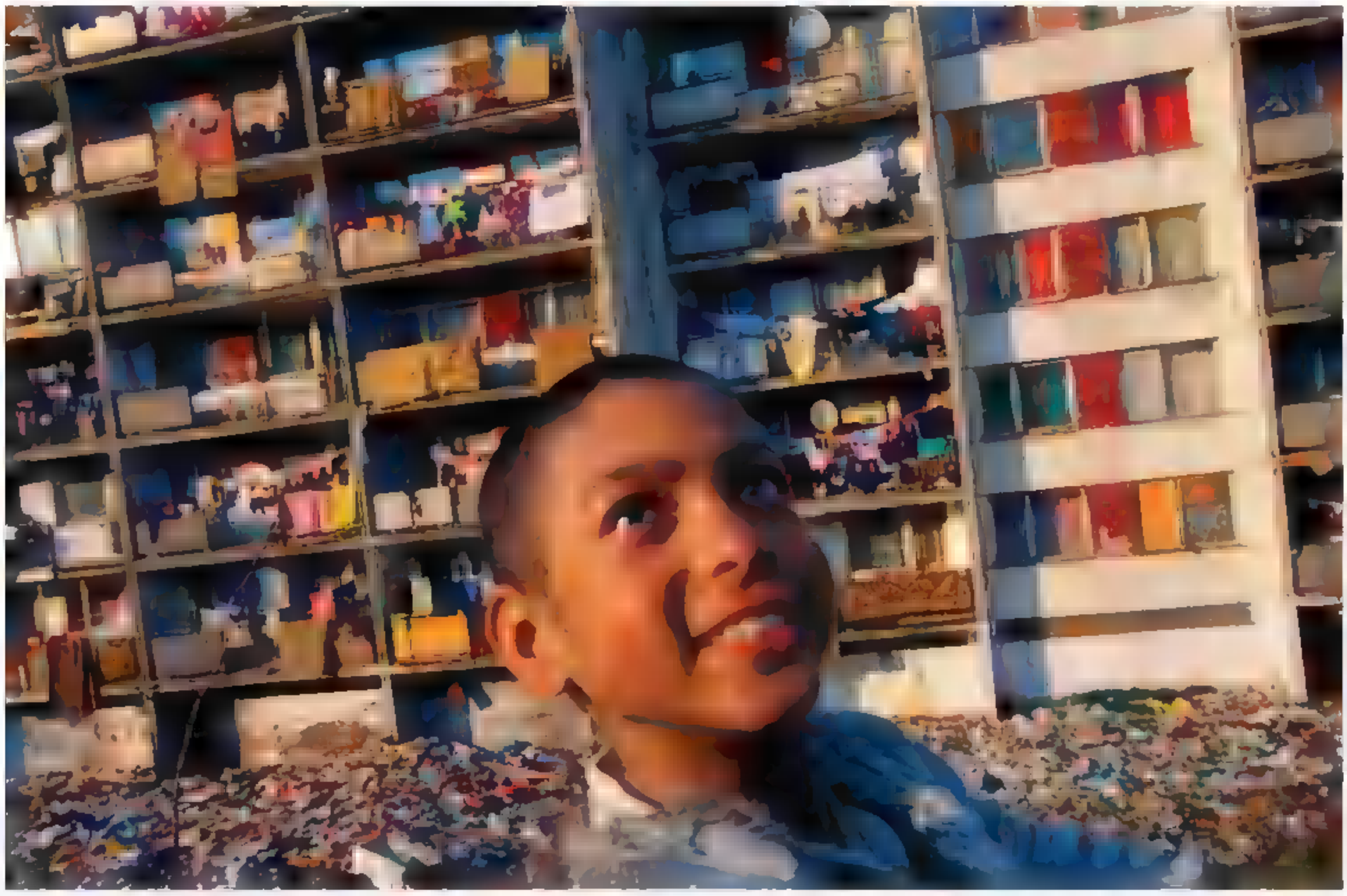
Unlike any other.

Mercedes-Benz

MBUSA.com

*Stated rates of acceleration are based on manufacturer's track results and may vary depending on model, environmental and road surface conditions, driving style, elevation and vehicle load. **Please always drive carefully, consistent with conditions and always obey local speed limits. S 550 shown in Black paint.

For more information on Mercedes-Benz products, call 1-800-FOR-MERCEDES, or visit MBUSA.com.



A child's smile for a visitor belies the garbage-strewn grimness of daily Romani life on the outskirts of Košice, Slovakia. Decaying Soviet-era housing blocks, where running water and electricity are uncertain commodities, have become part refuge, part trap, for Romani families driven from nearby communities by anti-Gypsy bigotry.

Jobless and homeless, a young Romani immigrant in France begged on Lyon's streets and found shelter in ■ vacant industrial building (left). Her native Romania has since joined the European Union. Eventually doors will be open to employment, but the EU parliament has acknowledged that Romani women "face extreme levels of discrimination."

There's relief for pain like this. Ask your doctor about Lyrica®.

Designed for Relief

Do you feel burning pain in your feet? Or tingling, numbness, stabbing or shooting sensations?

If so, you may have painful neuropathy, also known as nerve pain. This type of pain is different from musculoskeletal (muscle or joint) pain, and may need a different type of treatment. Only Lyrica (pronounced LEER-i-kah) is FDA-approved to treat two of the most common types of nerve pain, Diabetic Nerve Pain and Pain after Shingles. Lyrica is specially designed to provide the relief you need. It works on the nerves that cause this pain. So you can start to think about other things besides your pain. Ask your doctor if Lyrica can help. Lyrica is one of several treatments for you and your doctor to consider.

Prescription Lyrica is not for everyone. Some of the most common side effects of Lyrica are dizziness and sleepiness. Others are dry mouth, swelling of hands and feet, blurry vision, weight gain, constipation, euphoria, balance problems, increased appetite and trouble concentrating. Tell your doctor right away about any serious allergic reaction that causes swelling of the face, mouth or neck or affects your breathing or your skin. Also tell your doctor about any changes in your eyesight, muscle pain along with ■ fever or tired feeling or if you are planning to father a child. You may have a higher chance of swelling, hives or gaining weight if you are also taking certain diabetes or high blood pressure medicines. And, if you drink alcohol or take medicines that make you sleepy, you may feel more sleepy when you start Lyrica. You should not drive or operate machinery until you know how Lyrica affects you. If you have had a drug or alcohol problem, you may be more likely to misuse Lyrica. You should talk with your doctor before you stop taking Lyrica or any other prescription medication. *Please see important patient information on adjacent pages.*

To learn more visit www.lyrica.com or call toll-free 1-888-9-LYRICA (1-888-959-7422).

You are encouraged to report negative side effects of prescription drugs to the FDA. Visit www.FDA.gov/medwatch or call 1-800-FDA-1088.

PATIENT INFORMATION

Lyrica® *(pregabalin)* Capsules Ⓒ
(LEER-i-kah)

Read the Patient Information that comes with LYRICA before you start taking it and each time you get a refill. There may be new information. This leaflet does not take the place of talking with your doctor about your condition or treatment. If you have any questions about LYRICA, ask your doctor or pharmacist.

What is the most important information I should know about LYRICA?

1. **LYRICA may cause serious allergic reactions.**
   - **Call your doctor right away if you think you have any of the following symptoms of a serious allergic reaction:**
     - **swelling of the face, mouth, lips, gums, tongue or neck**
     - **have any trouble breathing**
     - **Other allergic reactions may include rash, hives and blisters.**
2. **LYRICA may cause dizziness and sleepiness.**
   - **Do not drive a car, work with machines, or do other dangerous activities until you know how LYRICA affects how alert you are. Ask your doctor when it is okay to do these activities.**
3. **LYRICA may cause problems with your eyesight, including blurry vision.**
   - **Call your doctor if you have any changes in your eyesight.**

What is LYRICA?

LYRICA is a prescription medicine used in adults, 18 years and older, to treat:

- pain from damaged nerves (neuropathic pain) that happens with diabetes
- pain from damaged nerves (neuropathic pain) that follows healing of shingles (a painful rash that comes after a herpes zoster infection)
- partial seizures when taken together with other seizure medicines
- fibromyalgia

LYRICA has not been studied in children under 18 years of age.

Pain from Damaged Nerves (neuropathic pain)

Diabetes and shingles can damage your nerves. Pain from damaged nerves may feel sharp, burning, tingling, shooting, or numb. If you have diabetes, the pain can be in your arms, hands, fingers, legs, feet, or toes. If you have shingles, the pain is in the area of your rash. You may experience this kind of pain even with a very light touch. LYRICA can help relieve the pain. Some people taking LYRICA had less pain by the end of the first week of LYRICA therapy. LYRICA may not work for everyone.

Partial Seizures

Partial seizures start in one part of the brain. A seizure can make you fearful, confused, or just feel "funny". You may smell strange smells. A seizure may cause your arm or leg to jerk or shake. It can spread to other parts of your brain, make you pass out, and cause your whole body to start jerking.

LYRICA can lower the number of seizures for people who are already taking seizure medicine.

Fibromyalgia

Fibromyalgia is a condition which includes widespread muscle pain and difficulty performing daily activities. LYRICA can help relieve the pain and improve function. Some people taking LYRICA had less pain by the end of the first week of LYRICA therapy. LYRICA may not work for everyone.

Who Should Not Take LYRICA?

Do not take LYRICA if you are allergic to any of its ingredients. The active ingredient is pregabalin. See the end of this leaflet for a complete list of ingredients in LYRICA.

What should I tell my doctor before taking LYRICA?

Tell your doctor about all your medical conditions, including if you:

- **have any kidney problems or get kidney dialysis**
- **have heart problems including heart failure**
- **have a bleeding problem or a low blood platelet count**
- **are pregnant or plan to become pregnant.** It is not known if LYRICA may harm your unborn baby. You and your doctor will have to decide if LYRICA is right for you while you are pregnant.
- **are breastfeeding.** It is not known if LYRICA passes into breast milk and if it can harm your baby. You and your doctor should decide whether you should take LYRICA or breastfeed, but not both.

Tell your doctor about all the medicines you take including prescription or non-prescription medicines, vitamins or herbal supplements. LYRICA and other medicines may affect each other. Especially tell your doctor if you take:

- angiotensin converting enzyme (ACE) inhibitors. You may have a higher chance for swelling and hives if these medicines are taken with LYRICA. See "What is the most important information I should know about LYRICA?"
- Avandia® (rosiglitazone) or Actos® (pioglitazone) for diabetes. You may have a higher chance of weight gain or swelling if these medicines are taken with LYRICA. See "What are the possible side effects of LYRICA."
- any narcotic pain medicine (such as oxycodone), tranquilizers or medicines for anxiety (such as lorazepam). You may have a higher chance for dizziness and sleepiness if these medicines are taken with LYRICA. See "What is the most important information I should know about LYRICA?"
- any medicines that make you sleepy

Know all the medicines you take. Keep a list of them with you to show your doctor and pharmacist each time you get a new medicine.

Tell your doctor if you plan to father a child. Animal studies showed that pregabalin, the active ingredient in LYRICA, made male animals less fertile and caused sperm abnormalities. Also, in animal studies, birth defects occurred in the offspring of male animals who

were treated with pregabalin. It is not known if these effects would happen in people.

How should I take LYRICA?

- Take LYRICA exactly as prescribed. Your doctor may adjust your dose during treatment. Do not change your dose without talking to your doctor.
- Do not stop taking LYRICA suddenly without talking to your doctor. If you stop taking LYRICA suddenly, you may have headaches, nausea, diarrhea or trouble sleeping. Talk with your doctor about how to slowly stop LYRICA.
- LYRICA is usually taken 2 or 3 times a day, depending on your medical condition. Your doctor will tell you how much LYRICA to take and when to take it. Take LYRICA at the same times each day.
- LYRICA may be taken with or without food.
- If you miss a dose by a few hours, take it as soon as you remember. If it is close to your next dose, just take LYRICA at your next regular time. **Do not** take two doses at the same time.
- If you take too much LYRICA, call your doctor or poison control center or go to the nearest emergency room right away.

What Should I Avoid While Taking LYRICA?

- **Do not drive a car, work with machines, or do other dangerous activities until you know how LYRICA affects how alert you are.** See "What is the most important information I should know about LYRICA?"
- **Do not drink alcohol while taking LYRICA.** LYRICA and alcohol can affect each other and increase side effects such as sleepiness and dizziness. This can be dangerous.

Do not take other medicines without talking to your doctor. Other medicines include prescription and non-prescription medicines, vitamins, and herbal supplements. LYRICA and other medicines may affect each other and increase the side effects of swelling, sleepiness and dizziness. Be especially careful about medicines that make you sleepy (such as sleeping pills, anxiety medicines, tranquilizers and some antihistamines, pain relievers and seizure medicines).

What are the possible side effects of LYRICA?
LYRICA may cause side effects including:

- **allergic reactions.** See "What is the most important information I should know about LYRICA?"
- **weight gain and swelling of the hands and feet (edema).** Weight gain may affect the management of diabetes. Weight gain and swelling can also be a serious problem for people with heart problems.
- **dizziness and sleepiness.** See "What is the most important information I should know about LYRICA?"
- **eyesight problems.** See "What is the most important information I should know about LYRICA?"
- **unexplained muscle problems, such as muscle pain, soreness, or weakness.** If you develop these symptoms, especially if you also feel sick and have a fever, tell your doctor right away.

The most common side effects of LYRICA are:

- dizziness
- blurry vision
- weight gain
- sleepiness
- trouble concentrating
- swelling of hands and feet
- dry mouth

LYRICA caused skin sores in animals. Although skin sores were not seen in studies in people, if you have diabetes, you should pay extra attention to your skin while taking LYRICA and tell your doctor of any sores or skin problems.

LYRICA may cause some people to feel "high." Tell your doctor, if you have abused prescription medicines, street drugs, or alcohol in the past.

Tell your doctor about any side effect that bothers you or that does not go away.

These are not all the side effects of LYRICA. For more information, ask your doctor or pharmacist.

How should I store LYRICA?

- Store LYRICA at room temperature, 59 to 86° F (15 to 30° C) in its original package.
- Safely throw away LYRICA that is out of date or no longer needed.
- **Keep LYRICA and all medicines out of the reach of children.**

General information about LYRICA
Medicines are sometimes prescribed for conditions other than those listed in patient information leaflets. Do not use LYRICA for a condition for which it was not prescribed. Do not give LYRICA to other people, even if they have the same symptoms you have. It may harm them.

This leaflet summarizes the most important information about LYRICA. If you would like more information, talk with your doctor. You can ask your doctor or pharmacist for information about LYRICA that is written for health professionals.

You can also visit the LYRICA website at www.LYRICA.com or call 1-866-4LYRICA.

What are the ingredients In LYRICA?
Active ingredient: pregabalin

Inactive ingredients: lactose monohydrate, cornstarch, talc;

Capsule shell: gelatin and titanium dioxide; Orange capsule shell: red iron oxide; White capsule shell: sodium lauryl sulfate, colloidal silicon dioxide. Colloidal silicon dioxide is a manufacturing aid that may or may not be present in the capsule shells.

Imprinting ink: shellac, black iron oxide, propylene glycol, potassium hydroxide.

Manufactured by:
Pfizer Pharmaceuticals LLC
Vega Baja, PR 00694

LAB-0299-5.0

Avandia is a registered trademark of GlaxoSmithKline.

Actos is a registered trademark of Takeda Chemicals Industries, Ltd. and used under license by Takeda Pharmaceuticals of America, Inc. and Eli Lilly and Co.

June 2007 LYU00399C

VISIONS OF EARTH

Kenya Hungry lions in ■ Masai Mara pride leave little of a wildebeest. "The animals were so involved eating that I was able to drive very close and take a picture standing on my car's roof," says photographer Michel Denis-Huot.

PHOTO CHRISTINE AND MICHEL DENIS-HUOT

California More than 3,000 wind turbines bristle across the hills of the Tehachapi-Mojave Wind Resource Area, generating enough electricity to serve a quarter million homes each year.

PHOTO JEFF KROEZE

California As his mother scatters his ashes from a lifeguard boat, friends of Emery Kauanui, Jr., gather in a memorial paddle-out off La Jolla's Windansea Beach on June 9, 2007. The pro surfer, 24, died the previous month.

See more Visions of Earth images at **visionsofearth.ngm.com.**

PHOTO: K. C. ALFRED, *SAN DIEGO UNION-TRIBUNE*/ZUMA PRESS

Wolves in Minnesota were taken off the endangered species list last year.

A Twist of the List

When the bald eagle flew off the endangered species list last year, everyone cheered. But what happens to the animals once they're off the list?

WOLVES Some conservation groups decry this year's planned delisting of the 1,500 or so wolves in the northern Rockies. States will manage the species, and hunting will be allowed. The groups say numbers could go perilously low. Some scientists say a 2007 delisting of upper Midwest wolves was too hasty. They want time to study the impact of crossbreeding with coyotes and Canadian wolves.

GRAY WHALES The population off the U.S. West Coast, delisted in 1994, is thriving. But their western Pacific cousins are still on the list. They migrate past a gantlet of Japanese fishing nets that accidentally kill a few each year. They also feed off Russia's coast where oil firms seek new resources; threats include possible oil spills and collisions with ships.

FALCONS The pesticide DDT reduced American peregrine numbers to a few hundred. The 1972 ban kicked off a comeback. Birds were bred and set free in countryside and cities. Tall buildings are like their ancestral cliffs, and urban pigeons are snacks on the wing. The falcon was delisted in 1999—an endangered-species success story. *—Helen Fields*

PHOTO: PHOTOLIBRARY

Good Night.
Good Morning.
Good Deal.

Staying asleep is just as important as falling asleep.*

Only Ambien CR has 2 layers of sleep relief to help you do both.

You're invited to get 7 nights of Ambien CR FREE.
Visit www.CRFree7Day.com or call 1-866-514-9884

*Helps you wake up less frequently and fall back to sleep faster. Proven effective for up to 7 hours in clinical studies.

AMBIEN CR is indicated for the treatment of insomnia.

IMPORTANT SAFETY INFORMATION

AMBIEN CR is a treatment option you and your healthcare provider can consider along with lifestyle changes and can be taken for as long as your provider recommends. Until you know how AMBIEN CR will affect you, you shouldn't drive or operate machinery. Be sure you're able to devote 7 to 8 hours to sleep before being active again. Sleepwalking, and eating or driving while not fully awake, with amnesia for the event, have been reported. If you experience any of these behaviors contact your provider immediately. In rare cases, sleep medicines may cause allergic reactions such as swelling of your tongue or throat, shortness of breath, or more severe results. If you have an allergic reaction while using AMBIEN CR, contact your doctor immediately. Side effects may include next-day drowsiness, dizziness, and headache. It's non-narcotic; however, like most sleep medicines, it has some risk of dependency. Don't take it with alcohol.

You are encouraged to report negative side effects of prescription drugs to the FDA. Visit www.fda.gov/medwatch or 1.800.FDA.1088.

AMBIEN CR®
ZOLPIDEM TARTRATE EXTENDED RELEASE (CIV)
6.25-MG & 12.5-MG EXTENDED RELEASE TABLETS

A good night's sleep from start to finish.™

sanofi aventis

Please see Important Patient Information on adjoining page.

INFORMATION FOR PATIENTS
Ambien CR® @
(zolpidem tartrate extended-release) tablets

AMBIEN CR®
(ZOLPIDEM TARTRATE EXTENDED RELEASE) C IV
6.25-MG & 12.5-MG EXTENDED RELEASE TABLETS

INFORMATION FOR PATIENTS TAKING AMBIEN CR

Your doctor has prescribed Ambien CR to help you sleep. The following information is intended to guide you in the safe use of this medicine. It is not meant to take the place of your doctor's instructions. If you have any questions about Ambien CR tablets be sure to ask your doctor or pharmacist.

Ambien CR is used to treat different types of sleep problems, such as

- trouble falling asleep
- waking up often during the night

Some people may have more than one of these problems.

Ambien CR belongs to a group of medicines known as the "sedative/hypnotics", or simply, sleep medicines. There are many different sleep medicines available to help people sleep better. Sleep problems are usually temporary, requiring treatment for only a short time, usually 1 or 2 days up to 1 or 2 weeks. Some people have chronic sleep problems that may require more prolonged use of sleep medicine. However, you should not use these medicines for long periods without talking with your doctor about the risks and benefits of prolonged use.

SIDE EFFECTS

Most common side effects:

- headache
- somnolence (sleepiness)
- dizziness

You may find that these medicines make you sleepy during the day. How drowsy you feel depends upon how your body reacts to the medicine, which sleep medicine you are taking, and how large a dose your doctor has prescribed. Daytime drowsiness is best avoided by taking the lowest dose possible that will still help you sleep at night. Your doctor will work with you to find the dose of Ambien CR that is best for you.

To manage these side effects while you are taking this medicine:

- When you first start taking Ambien CR or any other sleep medicine until you know whether the medicine will still have some carryover effect in you the next day, use extreme care while doing anything that requires complete alertness, such as driving a car, operating machinery, or piloting an aircraft.
- NEVER drink alcohol while you are being treated with Ambien CR or any sleep medicine. Alcohol can increase the side effects of Ambien CR or any other sleep medicine.
- Do not take any other medicines without asking your doctor first. This includes medicines you can buy without a prescription. Some medicines can cause drowsiness and are best avoided while taking Ambien CR.
- Always take the exact dose of Ambien CR prescribed by your doctor. Never change your dose without talking to your doctor first.

SPECIAL CONCERNS

There are some special problems that may occur while taking sleep medicines.

"Sleep-Driving" and other complex behaviors: There have been reports of people getting out of bed after taking a sleep medicine and driving their cars while not fully awake, often with no memory of the event. If you experience such an event, it should be reported to your doctor immediately, since "sleep-driving" can be dangerous. This behavior is more likely to occur when Ambien CR is taken with alcohol or other drugs such as those for the treatment of depression or anxiety. Other complex behaviors such as preparing and eating food, making phone calls, or having sex have been reported in people who are not fully awake after taking a sleep medicine. As with "sleep-driving", people usually do not remember these events.

Memory problems: Sleep medicines may cause a special type of memory loss or "amnesia." When this occurs, a person may not remember what has happened for several hours after taking the medicine. This is usually not a problem since most people fall asleep after taking the medicine.

Memory loss can be a problem, however, when sleep medicines are taken while traveling, such as during an airplane flight and the person wakes up before the effect of the medicine is gone. This has been called "traveler's amnesia."

Be sure to talk to your doctor if you think you are having memory problems. Although memory problems are not very common while taking Ambien CR, in most instances, they can be avoided if you take Ambien CR only when you are able to get a full night's sleep (7 to 8 hours) before you need to be active again.

Tolerance: When sleep medicines are used every night for more than a few weeks, they may lose their effectiveness to help you sleep. This is known as "tolerance". Sleep medicines should, in most cases, be used only for short periods of time, such as 1 or 2 days and generally no longer than 1 or 2 weeks. If your sleep problems continue, consult your doctor, who will determine whether other measures are needed to overcome your sleep problems.

Dependence: Sleep medicines can cause dependence, especially when these medicines are used regularly for longer than a few weeks or at high doses. Some people develop a need to continue taking their medicines. This is known as dependence or "addiction."

When people develop dependence, they may have difficulty stopping the sleep medicine. If the medicine is suddenly stopped, the body is not able to function normally and unpleasant symptoms may occur (see *Withdrawal*). They may find that they have to keep taking the medicines either at the prescribed dose or at increasing doses just to avoid withdrawal symptoms.

All people taking sleep medicines have some risk of becoming dependent on the medicine. However, people who have been dependent on alcohol or other drugs in the past may have a higher chance of becoming addicted to sleep medicines. This possibility must be considered before using these medicines for more than a few weeks.

If you have been addicted to alcohol or drugs in the past, it is important to tell your doctor before starting Ambien CR or any sleep medicine.

Withdrawal: Withdrawal symptoms may occur when sleep medicines are stopped suddenly after being used daily for a long time. In some cases, these symptoms can occur even if the medicine has been used for only a week or two.

In mild cases, withdrawal symptoms may include unpleasant feelings. In more severe cases, abdominal and muscle cramps, vomiting, sweating, shakiness, and rarely, seizures may occur. These more severe withdrawal symptoms are very uncommon.

Another problem that may occur when sleep medicines are stopped is known as "rebound insomnia." This means that a person may have more trouble sleeping the first few nights after the medicine is stopped than before starting the medicine. If you should experience rebound insomnia, do not get discouraged. This problem usually goes away on its own after 1 or 2 nights.

If you have been taking Ambien CR or any other sleep medicine for more than 1 or 2 weeks, do not stop taking it on your own. Always follow your doctor's directions.

Changes in behavior and thinking: Some people using sleep medicines have experienced unusual changes in their thinking and/or behavior. These effects are not common. However, they have included:

- more outgoing or aggressive behavior than normal
- confusion
- strange behavior
- agitation
- hallucinations
- worsening of depression
- suicidal thoughts

How often these effects occur depends on several factors, such as a person's general health, the use of other medicines, and which sleep medicine is being used.

It is also important to realize that it is rarely clear whether these behavior changes are caused by the medicine, an illness, or occur on their own. In fact, sleep problems that do not improve may be due to illnesses that were present before the medicine was used. If you or your family notice any changes in your behavior, or if you have any unusual or disturbing thoughts, call your doctor immediately.

Pregnancy: Sleep medicines may cause sedation of the unborn baby when used during the last weeks of pregnancy.

Be sure to tell your doctor if you are pregnant, if you are planning to become pregnant, or if you become pregnant while taking Ambien CR.

SAFE USE OF SLEEPING MEDICINES

To ensure the safe and effective use of Ambien CR or any other sleep medicine, you should observe the following cautions:

1. Ambien CR is a prescription medicine and should be used ONLY as directed by your doctor. Follow your doctor's instructions about how to take, when to take, and how long to take Ambien CR. Ambien CR tablets should not be divided, crushed, or chewed, and must be swallowed whole.
2. Never use Ambien CR or any other sleep medicine for longer than directed by your doctor.
3. If you develop an allergic reaction such as rash, hives, shortness of breath or swelling of your tongue or throat when using Ambien CR or any other sleep medicine, discontinue Ambien CR or other sleep medicine immediately and contact your doctor.
4. If you notice any unusual and/or disturbing thoughts or behavior during treatment with Ambien CR or any other sleep medicine, contact your doctor.
5. Tell your doctor about any medicines you may be taking, including medicines you may buy without a prescription. You should also tell your doctor if you drink alcohol. DO NOT use alcohol while taking Ambien CR or any other sleep medicine.
6. Do not take Ambien CR unless you are able to get a full night's sleep before you must be active again. For example, Ambien CR should not be taken on an overnight airplane flight of less than 7 to 8 hours since "traveler's amnesia" may occur.
7. Do not increase the prescribed dose of Ambien CR or any other sleep medicine unless instructed by your doctor.
8. When you first start taking Ambien CR or any other sleep medicine, until you know whether the medicine will still have some carryover effect in you the next day, use extreme care while doing anything that requires complete alertness, such as driving a car, operating machinery, or piloting an aircraft.
9. Be aware that you may have more sleeping problems the first night after stopping Ambien CR or any other sleep medicine.
10. Be sure to tell your doctor if you are pregnant, if you are planning to become pregnant, or if you become pregnant while taking Ambien CR or any other sleep medicine.
11. As with all prescription medicines, never share Ambien CR or any other sleep medicine with anyone else. Always store Ambien CR or any other sleep medicine in the original container that you received it in and store it out of reach of children.
12. Ambien CR works very quickly. You should only take Ambien CR right before going to bed and are ready to go to sleep.

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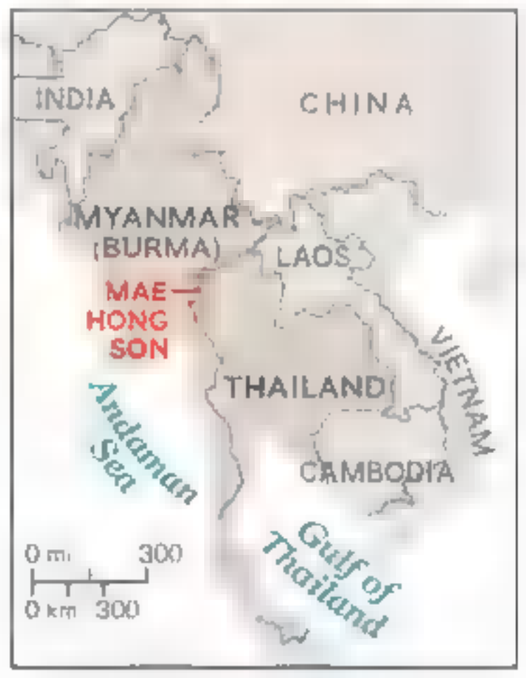
Camera-ready Refugees For generations, ethnic Padaung women from Myanmar have worn brass neck rings as ■ mark of beauty and cultural pride. From girlhood, coils are added over time, gradually pushing down the collarbone and ribs. The shoulders slope dramatically, making the neck appear longer (left). Now some women are rejecting the rings because the tradition has trapped them in what critics call "human zoos"—mock villages, many of them in Thailand's Mae Hong Son Province, where tourists buy tickets for a glimpse of exotic "giraffe women" (above). Girls in these places do not attend school. If they move to a refugee camp, they get an education, but opportunities to earn money—or leave the country—are limited. Local businesses profit from the tourist traffic, and some Padaung women welcome the modest income. Is this economic empowerment, then, or exploitation? "It depends whether these women are coerced," says National Geographic Explorer-in-Residence Wade Davis. For Thailand's Padaung women, the choice is very narrow. *—Alan Mairson*



Violence in Myanmar has driven thousands of refugees into Thailand.

PHOTOS: THIERRY FALISE, ONASIA. NGM MAPS

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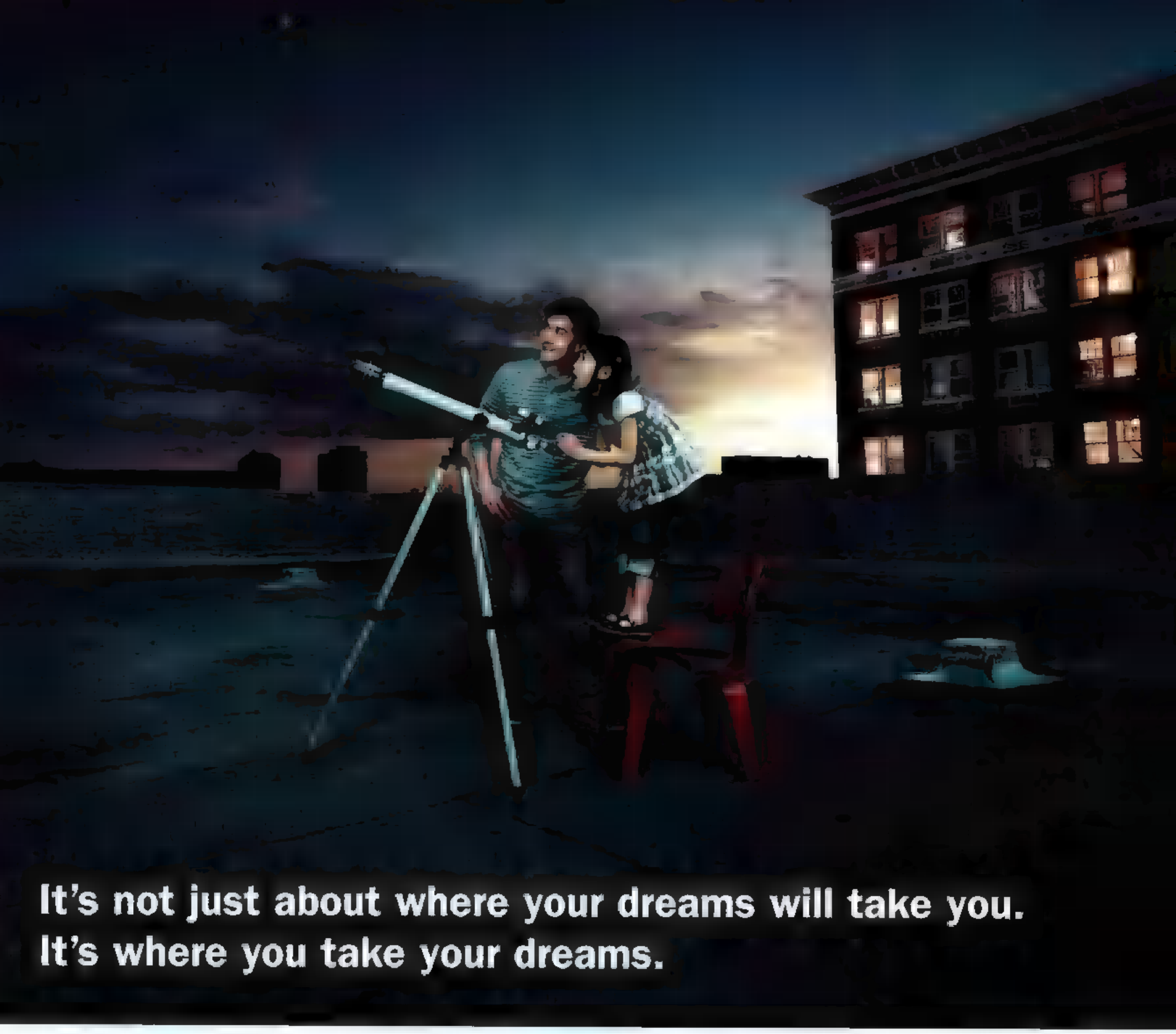
Chewing on Wisdom Teeth Conventional wisdom is to pull them lest they cause crowding, gum disease, or decay. A 2007 report by oral surgeons endorses that view. But not all dentists agree about third molars, whose nickname reflects their eruption at age 17 to 25, the alleged onset of smarts. Removal has a "small but significant" risk of ill effects, from nerve damage to infection, says Richard Niederman, director of the Forsyth Institute's Center for Evidence-Based Dentistry. Watch and wait is "good advice for a lot of people," adds Tufts University dentistry professor Anthony Silvestri. Early humans faced no dilemma. Jaws were roomier, diets chewier; third molars could sub for other teeth that bit the dust. *—Marc Silver*

ALSO KNOWN AS

20-year teeth (Turkey)
Mind teeth (Romania)
Love teeth (Korea)
Unknown-to-parent teeth (Japan)

PHOTO: REBECCA HALE, NG STAFF



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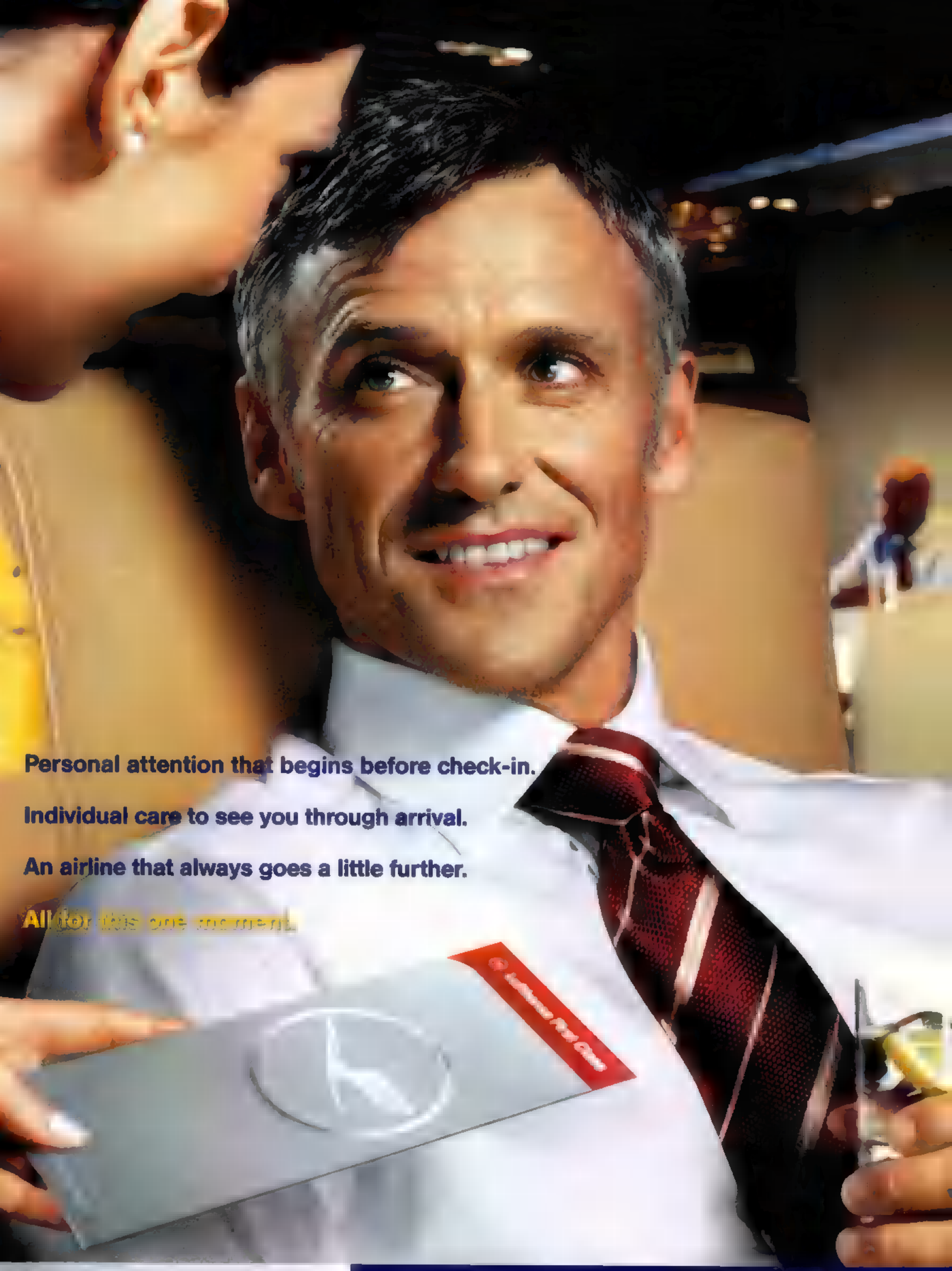
In 2007 the largest lake in the southeastern U.S. saw its levels fall to less than nine feet.

Exposed in Okeechobee For decades Lake Okeechobee hid its secrets in alligator-thick waters and layers of stinking muck. Last year drought shrank the Florida lake to its lowest level since 1932, unveiling an archaeological trove. Scouring the bed, scientists found ancient Indian artifacts, recent trash (left), and ■ century-old boat used in a long-gone catfish industry. "Over 3,000 years of history were uncovered," says archaeologist Chris Davenport. Autumn rains resubmerged most sites, but that's fine with him: "Protects them from looters." *—Neil Shea*

SATELLITE IMAGE: NASA/JPL, NGM MAPS. PHOTO: MARC SEROTA, GETTY IMAGES



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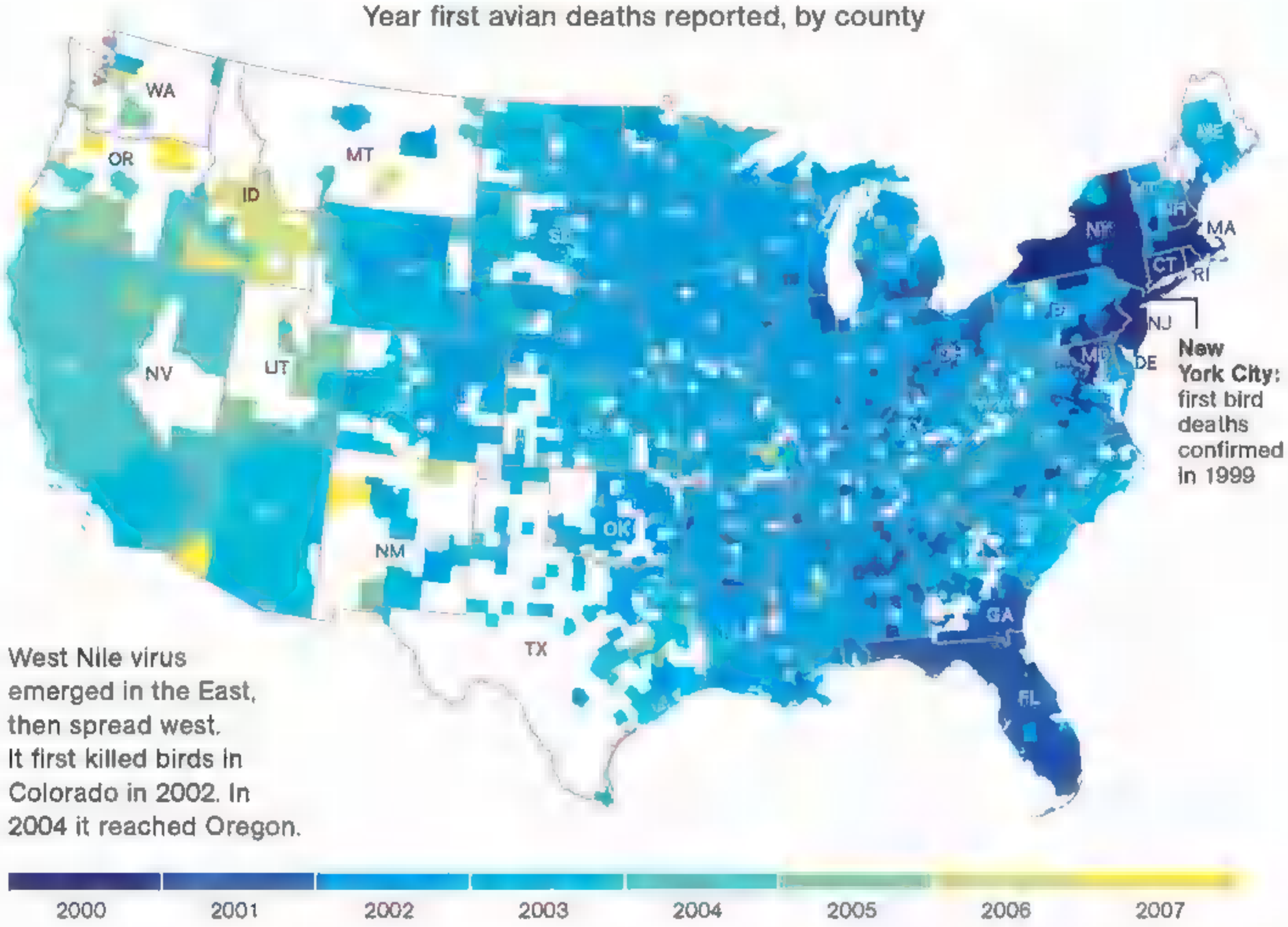
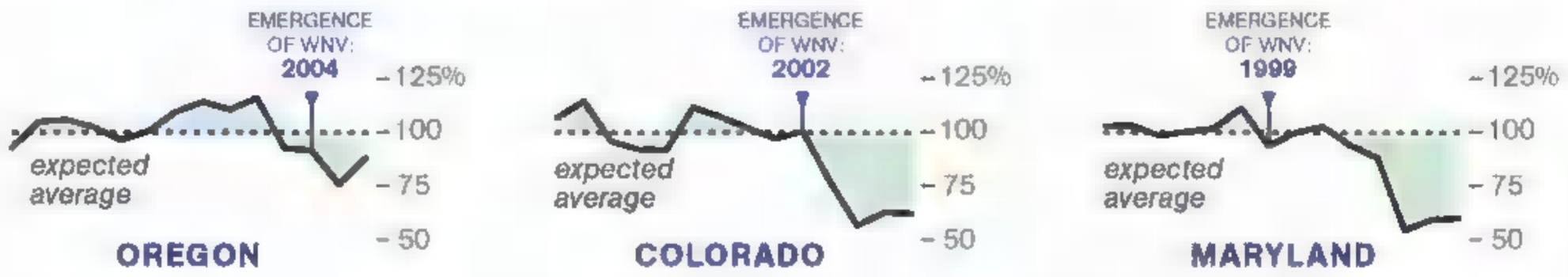
A Fatal Sweep for West Nile Virus

Year first avian deaths reported, by county



West Nile virus emerged in the East, then spread west. It first killed birds in Colorado in 2002. In 2004 it reached Oregon.

AMERICAN CROW POPULATION *percent change between actual count and expected, 1993–2006*



American crow

Though West Nile virus has killed more than 1,000 people in the U.S. and sickened many more, dead birds were the first sign of the mosquito-borne virus's emergence, in New York in 1999. Now ecologist Shannon LaDeau of the Smithsonian Migratory Bird Center at the National Zoo has used decades of data from birders to estimate an avian death toll in the millions. Crows were hardest hit, but chickadees, tufted titmice, and others also declined. Her data shows no signs of recovery among most affected species. The 2008 outlook depends on mosquito activity. If weather conditions enable the insects to thrive where the virus is present, cases could increase for both birds and humans. *—Chris Carroll*

MAP SOURCE: CENTERS FOR DISEASE CONTROL AND PREVENTION, NGM MAPS.
CHART SOURCE: SHANNON LADEAU. NGM ART. PHOTO: ARTHUR MORRIS, BIRDS AS ART

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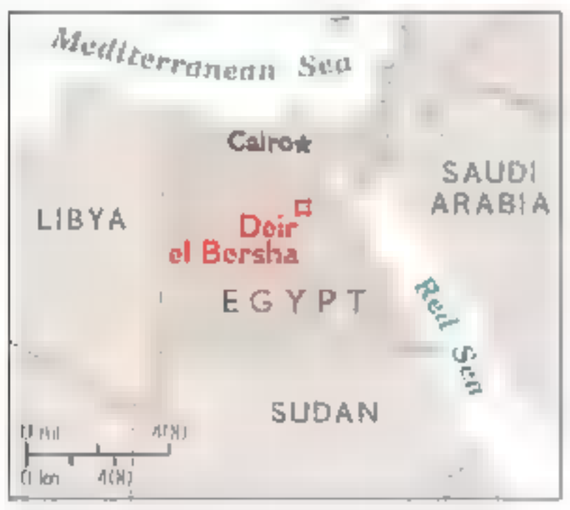
OPPORTUNITY STARTS WITH INTEL INSIDE.

Details From the Crypt Untouched for more than 4,000 years, a newly discovered burial in Egypt sheds light on a little-known time. Henu, the deceased, worked as an official in the provincial capital of Hermopolis while would-be kings fought for control of the country after the collapse of the glorious Old Kingdom. This was the First Intermediate Period, thought to be an era of chaos and misery, yet Henu's tomb indicates otherwise. The local governor was powerful enough to hand out political favors: He let Henu and other top aides build their tombs as extensions of revered Old Kingdom burials. The contents of Henu's tomb attest to prosperity. Plaster-over-wood models, about ten inches tall and meant to serve Henu in the afterlife, are exquisitely detailed: women in linen skirts grinding grain, men with clay-stained feet and hands making bricks, more women brewing beer. When archaeologists from the Deir el Bersha Project of the Catholic University at Leuven (in Belgium) opened the chamber in early 2007, they were astonished. "For this period the quality is exceptional," says lead investigator Marleen De Meyer. A CT scan of the mummy could reveal more surprises. De Meyer assumes Henu was a man—but you never know. *—A. R. Williams*



Linen shrouds the mummy of Henu, buried in a rock-cut tomb at Deir el Bersha in about 2050 B.C.

PHOTOS: MARLEEN DE MEYER

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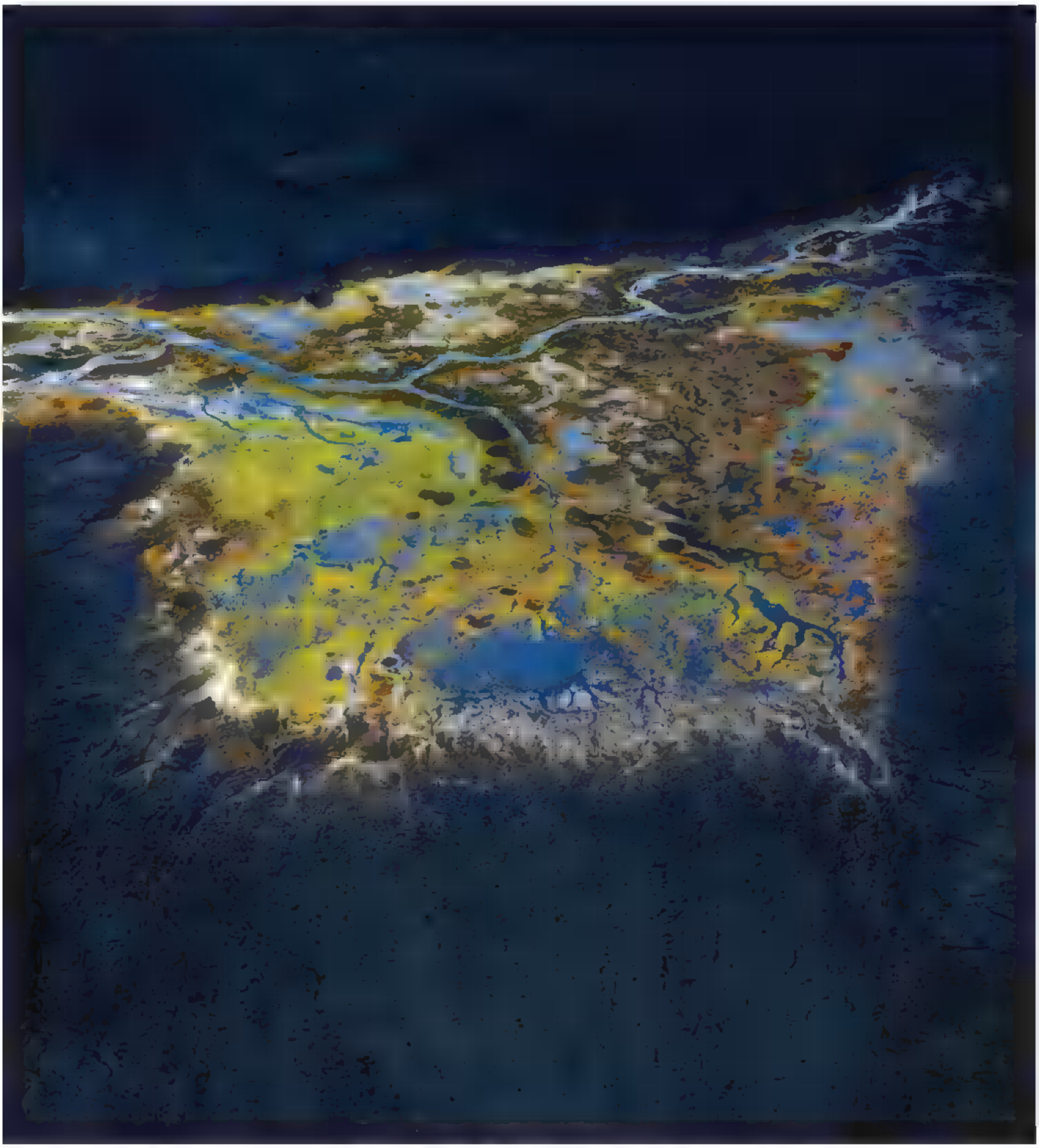
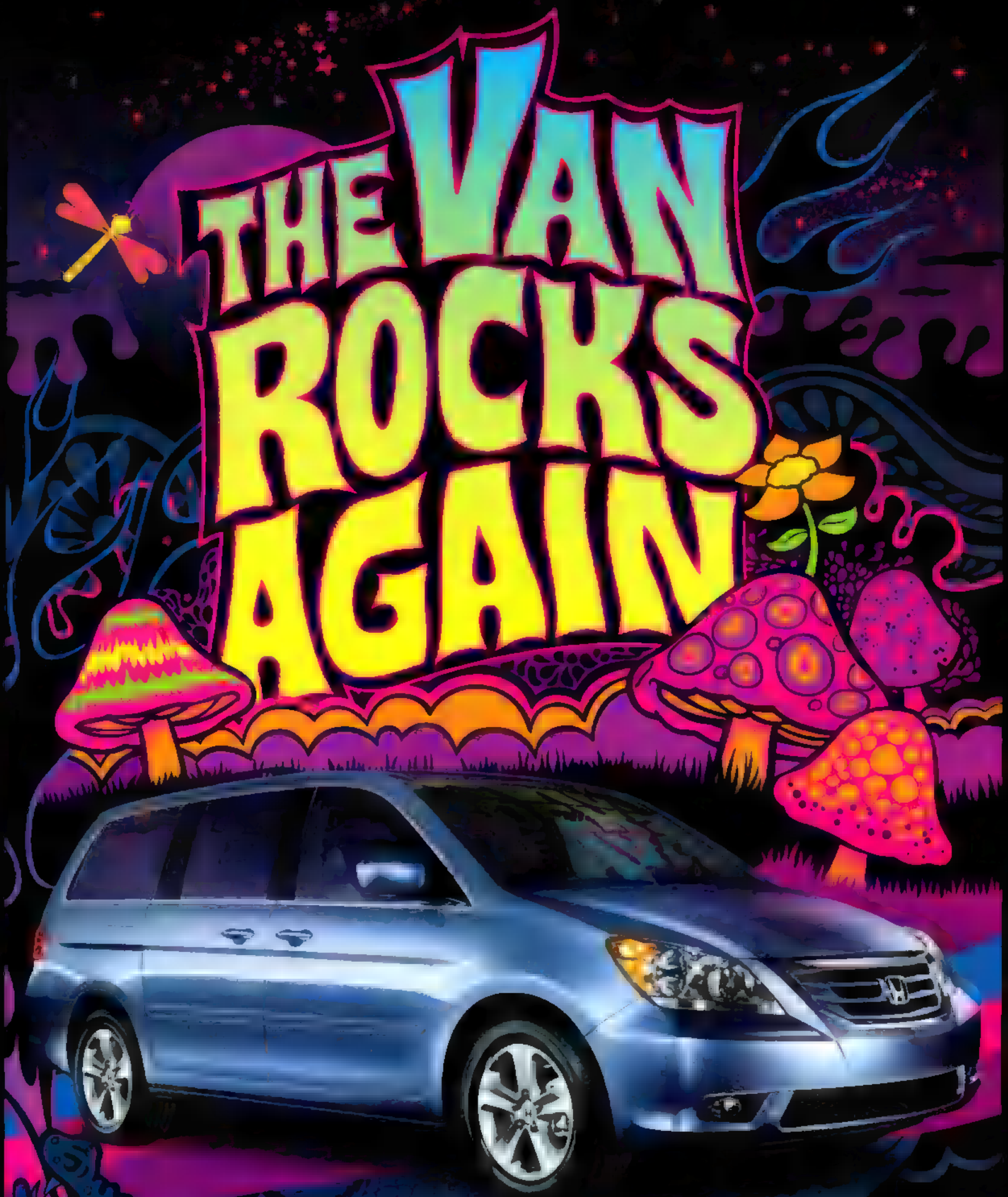


A blue, green, and brown bog in Iceland is surrounded by black volcanic ash.

Bog Lights Even in a land of geysers, glaciers, and black-sand beaches, a bog blooming amid volcanic ash demands ■ double take. Located in ■ flat stretch of south-central Iceland between two mountain ranges, the mire breaks up the barren region in a burst of fluorescent fertility. Volcanologist Haraldur Sigurdsson speculates that the ash blasted into being some 5,000 years ago, erupting from the Vatnaöldur fissure. A spring pokes through the porous soil, irrigating the oasis and merging with the Tungnaá River (entering the bog above, upper right, and exiting to the west). On a sunny day only the moss and grasses are lit up; the ash, known as tephra, absorbs the solar rays and blinks blackly back. *—Jeremy Berlin*

PHOTO: HANS STRAND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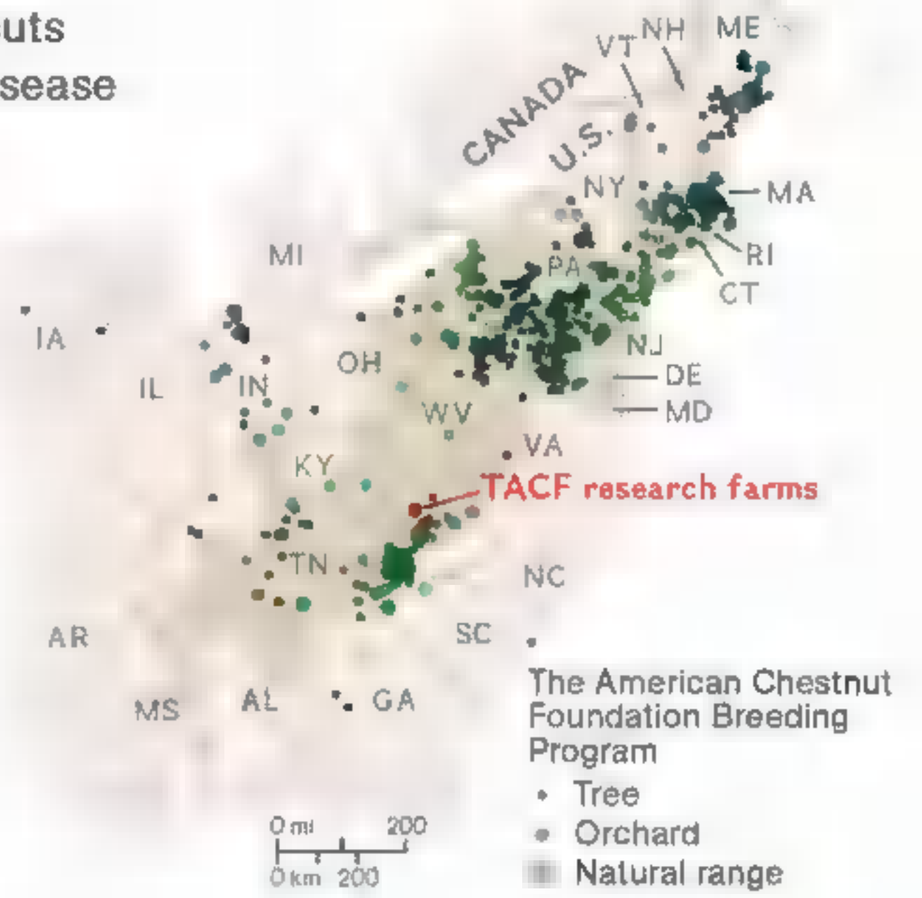
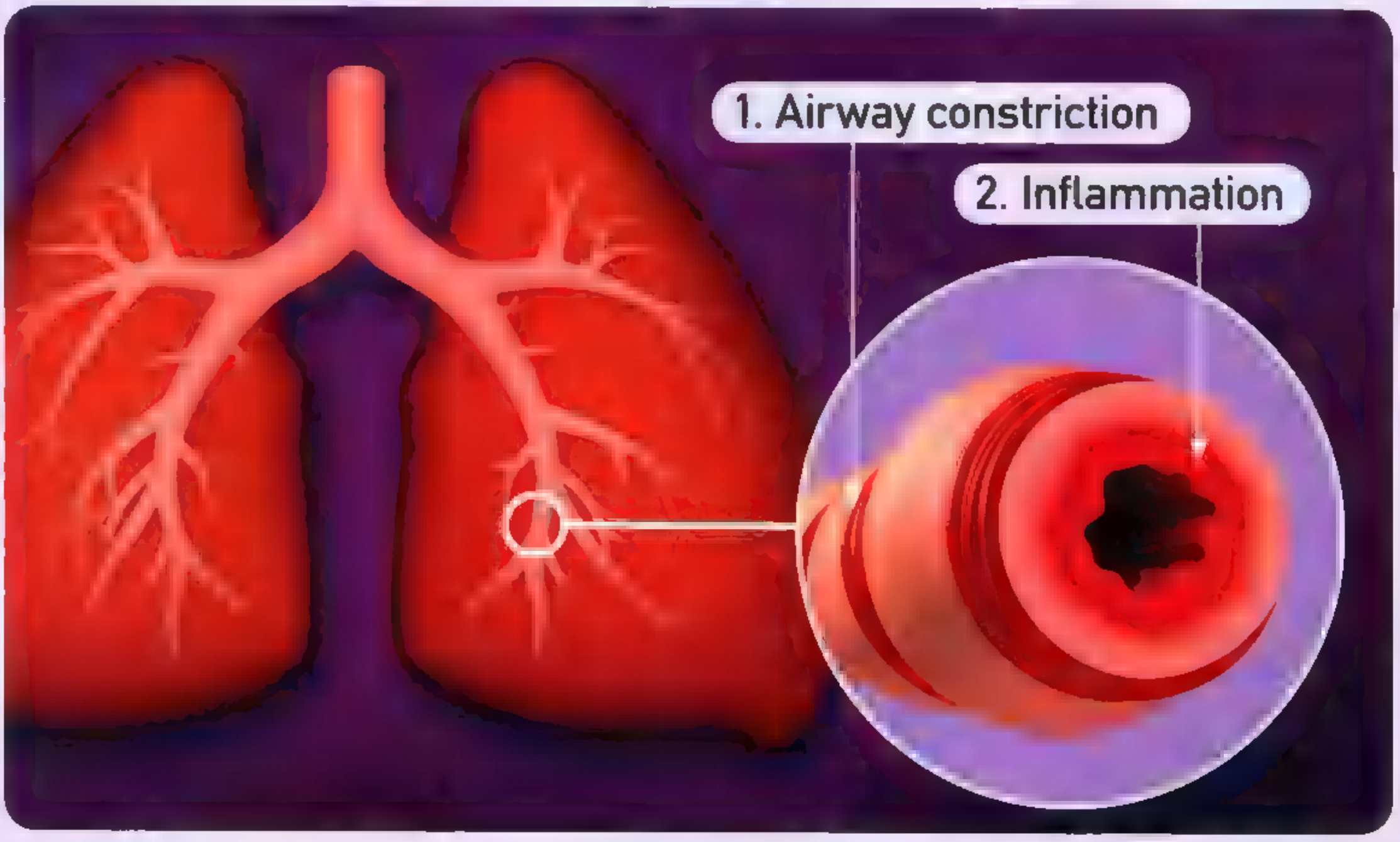
A New Chestnut Blight-resistant American chestnuts on a Virginia research farm are striking back at the fungal disease that wiped out four billion of the majestic trees in the early 1900s. The superior pollen of this newly developed breed may be the key to protecting trees from Maine to Alabama—and returning Appalachia to a time when spring meant American chestnuts in snowy bloom. Plant pathologist Fred Hebard has been on a 40-year crusade to do just that. He and his team at the American Chestnut Foundation pollinated about 500 trees last summer. Hundreds of devoted volunteers tend those trees and others in the foundation's orchards. Next year they'll sow a handful of forest test sites with what they hope are the first blight-resistant nuts. How will Hebard gauge success? "When I'm long gone, and someone 50 years from now measures one of our trees in the forest—a hundred feet tall and thriving." *—Shelley Sperry*



Each spiny bur of the *Castanea dentata* holds up to three nuts.

PHOTO: REBECCA HALE, NG STAFF. SOURCE: THE AMERICAN CHESTNUT FOUNDATION. NGM MAPS

Asthma has two main causes. Treating both with ADVAIR® helps prevent symptoms.



If your symptoms keep coming back, it could be that your controller is treating only one of the main causes.

ADVAIR

Help prevent symptoms. Treat both main causes.™

Ask your doctor if ADVAIR is right for you. For more information call 1-800-646-6644, or visit www.ADVAIR.com

Important Information about ADVAIR DISKUS. Prescription ADVAIR won't replace fast-acting inhalers for sudden symptoms and should not be taken more than twice a day. ADVAIR is for people who still have symptoms on another asthma controller, or who need two controllers. ADVAIR contains salmeterol. In patients with asthma, medicines like salmeterol may increase the chance of asthma-related death. So ADVAIR is not for people whose asthma is well controlled on another controller medicine.

Talk to your doctor about the risks and benefits of treating your asthma with ADVAIR. Do not use ADVAIR with long-acting beta$_2$-agonists for any reason. If you are taking ADVAIR, see your doctor if your asthma does not improve or gets worse. Tell your doctor if you have a heart condition or high blood pressure. Some people may experience increased blood pressure, heart rate, or changes in heart rhythm. ADVAIR is for patients 4 years and older. For patients 4 to 11 years old, ADVAIR 100/50 is for those who have asthma symptoms while on an inhaled corticosteroid.

Please see important information about ADVAIR on the next page.

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ADVAIR DISKUS® 100/50

(fluticasone propionate 100 mcg and salmeterol 50 mcg inhalation powder)

Important Information about ADVAIR DISKUS

ADVAIR DISKUS® 100/50, 250/50, 500/50

(fluticasone propionate 100, 250, 500 mcg and salmeterol 50 mcg inhalation powder)

What is the most important information I should know about ADVAIR DISKUS?

In patients with asthma, long-acting beta$_2$-agonist medicines such as salmeterol (one of the medications in ADVAIR®) may increase the chance of death from asthma problems. In a large asthma study, more patients who used salmeterol died from asthma problems compared with patients who did not use salmeterol. So ADVAIR is not for patients whose asthma is well controlled on another asthma controller medicine such as low- to medium-dose inhaled corticosteroids or only need a fast-acting inhaler once in a while. Talk with your doctor about this risk and the benefits of treating your asthma with ADVAIR.

ADVAIR should not be used to treat a severe attack of asthma or chronic obstructive pulmonary disease (COPD) requiring emergency medical treatment.

ADVAIR should not be used to relieve sudden symptoms or sudden breathing problems. Always have a fast-acting inhaler with you to treat sudden breathing difficulty. If you do not have a fast-acting inhaler, contact your doctor to have one prescribed for you.

What is ADVAIR DISKUS?

There are two medicines in ADVAIR: fluticasone propionate, an inhaled anti-inflammatory belonging to a group of medicines commonly referred to as corticosteroids; and salmeterol, a long-acting, inhaled bronchodilator belonging to a group of medicines commonly referred to as beta$_2$-agonists. There are 3 strengths of ADVAIR: 100/50, 250/50, 500/50.

For Asthma

- ADVAIR is approved for the maintenance treatment of asthma in patients 4 years of age and older. ADVAIR should only be used if your doctor decides that another asthma controller medicine alone does not control your asthma or that you need 2 asthma controller medications.
- The strength of ADVAIR approved for patients ages 4 to 11 years who experience symptoms on an inhaled corticosteroid is ADVAIR DISKUS 100/50. All 3 strengths are approved for patients with asthma ages 12 years and older.

For COPD associated with chronic bronchitis

ADVAIR 250/50 is the only approved dose for the maintenance treatment of airflow obstruction in patients with COPD associated with chronic bronchitis. The benefit of using ADVAIR for longer than 6 months has not been evaluated. The way anti-inflammatories work in the treatment of COPD is not well defined.

Who should not take ADVAIR DISKUS?

You should not start ADVAIR if your asthma is becoming significantly or rapidly worse, which can be life threatening. Serious respiratory events, including death, have been reported in patients who started taking salmeterol in this situation, although it is not possible to tell whether salmeterol contributed to these events. This may also occur in patients with less severe asthma.

You should not take ADVAIR if you have had an allergic reaction to it or any of its components (salmeterol, fluticasone propionate, or lactose). Tell your doctor if you are allergic to ADVAIR, any other medications, or food products. If you experience an allergic reaction after taking ADVAIR, stop using ADVAIR immediately and contact your doctor. Allergic reactions are when you experience one or more of the following: choking; breathing problems; swelling of the face, mouth and/or tongue; rash; hives; itching; or welts on the skin.

Tell your doctor about the following:

- If you are using your fast-acting inhaler more often or using more doses than you normally do (e.g., 4 or more inhalations of your fast-acting inhaler for 2 or more days in a row or a whole canister of your fast-acting inhaler in 8 weeks' time), it could be a sign that your asthma is getting worse. If this occurs, tell your doctor immediately.
- If you have been using your fast-acting inhaler regularly (e.g., four times a day). Your doctor may tell you to stop the regular use of these medications.
- If your peak flow meter results decrease. Your doctor will tell you the numbers that are right for you.
- If you have asthma and your symptoms do not improve after using ADVAIR regularly for 1 week.
- If you have been on an oral steroid, like prednisone, and are now using ADVAIR. You should be very careful as you may be less able to heal after surgery, infection, or serious injury. It takes a number of months for the body to recover its ability to make its own steroid hormones after use of oral steroids. Switching from an oral steroid may also unmask a condition previously suppressed by the oral steroid such as allergies, conjunctivitis, eczema, arthritis, and eosinophilic conditions. Symptoms of an eosinophilic condition can include rash, worsening breathing problems, heart complications, and/or feeling of "pins and needles" or numbness in the arms and legs. Talk to your doctor immediately if you experience any of these symptoms.
- Sometimes patients experience unexpected bronchospasm right after taking ADVAIR. This condition can be life threatening and if it occurs, you should immediately stop using ADVAIR and seek immediate medical attention.
- If you have any type of heart disease such as coronary artery disease, irregular heart beat or high blood pressure, ADVAIR should be used with caution. Be sure to talk with your doctor about your condition because salmeterol, one of the components of ADVAIR, may affect the heart by increasing heart rate and blood pressure. It may cause symptoms such as heart fluttering, chest pain, rapid heart rate, tremor, or nervousness.
- If you have seizures, overactive thyroid gland, liver problems, or are sensitive to certain medications for breathing.
- If your breathing problems get worse over time or if your fast-acting inhaler does not work as well for you while using ADVAIR. If your breathing problems worsen quickly, get emergency medical care.
- If you have been exposed to or currently have chickenpox or measles or if you have an immune system problem. Patients using medications that weaken the immune system are more likely to get infections than healthy individuals. ADVAIR contains a corticosteroid (fluticasone propionate) which may weaken the immune system. Infections like chickenpox and measles, for example, can be very serious or even fatal in susceptible patients using corticosteroids.

How should I take ADVAIR DISKUS?

ADVAIR should be used 1 inhalation, twice a day (morning and evening). ADVAIR should never be taken more than 1 inhalation twice a day. The full benefit of taking ADVAIR may take 1 week or longer.

If you miss a dose of ADVAIR, just skip that dose. Take your next dose at your usual time. Do not take two doses at one time.

Do not stop using ADVAIR unless told to do so by your doctor because your symptoms might get worse.

Do not change or stop any of your medicines used to control or treat your breathing problems. Your doctor will adjust your medicines as needed.

When using ADVAIR, remember:

- Never breathe into or take the DISKUS® apart.
- Always use the DISKUS in a level position.
- After each inhalation, rinse your mouth with water without swallowing.
- Never wash any part of the DISKUS. Always keep it in a dry place.
- Never take an extra dose, even if you feel you did not receive a dose.
- Discard 1 month after removal from the foil pouch.
- Do not use ADVAIR with a spacer device.

Children should use ADVAIR with an adult's help as instructed by the child's doctor.

Can I take ADVAIR DISKUS with other medications?

Tell your doctor about all the medications you take, including prescription and nonprescription medications, vitamins, and herbal supplements.

If you are taking ADVAIR DISKUS, do not use other long-acting beta$_2$-agonist–containing medications, such as SEREVENT® DISKUS or Foradil® Aerolizer,® or any reason.

If you take ritonavir (an HIV medication), tell your doctor. Ritonavir may interact with ADVAIR and could cause serious side effects. The anti-HIV medicines Norvir® Soft Gelatin Capsules, Norvir Oral Solution, and Kaletra® contain ritonavir.

No formal drug interaction studies have been performed with ADVAIR.

In clinical studies, there were no differences in effects on the heart when ADVAIR was taken with varying amounts of albuterol. The effect of using ADVAIR in patients with asthma while taking more than 9 puffs a day of albuterol has not been studied.

ADVAIR should be used with extreme caution during and up to 2 weeks after treatment with monoamine oxidase (MAO) inhibitors or tricyclic antidepressants since these medications can cause ADVAIR to have an even greater effect on the circulatory system.

ADVAIR should be used with caution in people who are taking ketoconazole (an antifungus medication) or other drugs broken down by the body in a similar way. These medications can cause ADVAIR to have greater steroid side effects.

Generally, people with asthma should not take beta-blockers because they counteract the effects of beta$_2$-agonists and may also cause severe bronchospasm. However, in some cases, for instance, following a heart attack, selective beta-blockers may still be used if there is no acceptable alternative.

The ECG changes and/or low blood potassium that may occur with some diuretics may be made worse by ADVAIR, especially at higher-than-recommended doses. Caution should be used when these drugs are used together.

In clinical studies, there was no difference in side effects when ADVAIR was taken with methylxanthines (e.g., theophylline) or with FLONASE® (fluticasone propionate).

What are other important safety considerations with ADVAIR DISKUS?

Pneumonia: Lower respiratory tract infections, including pneumonia, have been reported with the use of inhaled corticosteroids, including ADVAIR. There was a higher incidence of pneumonia reported in patients with COPD taking ADVAIR DISKUS in clinical studies.

Osteoporosis: Long-term use of inhaled corticosteroids may result in bone loss (osteoporosis). Patients who are at risk for increased bone loss (tobacco use, advanced age, inactive lifestyle, poor nutrition, family history of osteoporosis, or long-term use of drugs such as corticosteroids) may have a greater risk with ADVAIR. If you have risk factors for bone loss, you should talk to your doctor about ways to reduce your risk and whether you should have your bone density evaluated.

Glaucoma and cataracts: Glaucoma, increased pressure in the eyes, and cataracts have been reported with the use of inhaled steroids, including fluticasone propionate, a medicine contained in ADVAIR. Regular eye examinations should be considered if you are taking ADVAIR.

Blood sugar: Salmeterol may affect blood sugar and/or cause low blood potassium in some patients, which could lead to a side effect like an irregular heart rate. Significant changes in blood sugar and blood potassium were seen infrequently in clinical studies with ADVAIR.

Growth: Inhaled steroids may cause a reduction in growth velocity in children and adolescents.

Steroids: Taking steroids can affect your body's ability to make its own steroid hormones, which are needed during infections and times of severe stress to your body, such as an operation. These effects can sometimes be seen with inhaled steroids (but it is more common with oral steroids), especially when taken at higher-than-recommended doses over a long period of time. In some cases, these effects may be severe. Inhaled steroids often help control symptoms with less side effects than oral steroids.

Yeast infections: Patients taking ADVAIR may develop yeast infections of the mouth and/or throat ("thrush") that should be treated by their doctor.

Tuberculosis or other untreated infections: ADVAIR should be used with caution, if at all, in patients with tuberculosis, herpes infections of the eye, or other untreated infections.

What are the other possible side effects of ADVAIR DISKUS?

ADVAIR may produce side effects in some patients. In clinical studies, the most common side effects with ADVAIR included:

- Respiratory infections
- Throat irritation
- Hoarseness
- Sinus infection
- Yeast infection of the mouth
- Bronchitis
- Cough
- Headaches
- Nausea and vomiting
- Diarrhea
- Musculoskeletal pain
- Dizziness
- Fever
- Ear, nose, and throat infections
- Nosebleed

Tell your doctor about any side effect that bothers you or that does not go away. These are not all the side effects with ADVAIR. Ask your doctor or pharmacist for more information.

What if I am pregnant, planning to become pregnant, or nursing?

Talk to your doctor about the benefits and risks of using ADVAIR during pregnancy, labor, or if you are nursing. There have been no studies of ADVAIR used during pregnancy, labor, or in nursing women. Salmeterol is known to interfere with labor contractions. It is not known whether ADVAIR is excreted in breast milk, but other corticosteroids have been detected in human breast milk. Fluticasone propionate, like other corticosteroids, has been associated with birth defects in animals (e.g., cleft palate and fetal death). Salmeterol showed no effect on fertility in rats at 180 times the maximum recommended daily dose.

What other important tests were conducted with ADVAIR?

There is no evidence of enhanced toxicity with ADVAIR compared with the components administered separately. In animal studies with doses much higher than those used in humans, salmeterol was associated with uterine tumors. Your healthcare professional can tell you more about how drugs are tested on animals and what the results of these tests may mean to your safety.

For more information on ADVAIR DISKUS

This page is only a brief summary of important information about ADVAIR DISKUS. For more information, talk to your doctor. You can also visit www.ADVAIR.com or call 1-888-825-5249. Patients receiving ADVAIR DISKUS should read the medication guide provided by the pharmacist with the prescription.

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GlaxoSmithKline

GlaxoSmithKline
Research Triangle Park, NC 27709
ADD: 2PI October 2007

Amish man's new miracle idea helps home heat bills hit rock bottom

Miracle heaters being given away free with orders for real Amish fireplace mantles to launch the new invention that slashes heat bills, but Amish craftsmen under strain of winter rush impose household limit of 2

Saves money: uses less energy than a coffee maker, so leave it on day and night and never be cold again

By MARK WOODS
Universal Media Syndicate

■ **GENUINE AMISH MANTLES MADE IN THE USA:** Amish craftsman are pleased that Heat Surge officials have provided proof of certification of the coveted UL Listing for the miracle heater. Now, everyone wants to save money on heat bills this winter, so entire Amish communities are working from the crack of dawn to finish. These fine solid wood Amish made fireplace mantles are built to last forever. The solid oak mantle is ■ real steal at just two hundred ninety-eight dollars because all those who beat the order deadline by calling the National Hotline at 1-800-242-6155 to order the fireplace mantles are actually getting the imported hi-tech Fireless Flame HEAT SURGE miracle heaters for free.

(UMS) Everyone hates high heat bills. But we're all sick and tired of turning down the thermostat and always being cold.

Well now, brand new HEAT SURGE™ miracle heaters are actually being given away free to the general public for the next seven days starting at precisely 8:00 a.m. today.

The only thing readers have to do is call the National Distribution Hotline before the 7 day deadline with their order for the handmade Amish Fireplace Mantles. Everyone who does is instantly being awarded the miracle heaters absolutely free.

This is all happening to launch the new HEAT SURGE Roll-n-Glow™ Amish Fireplace that actually rolls from room to room so you can take the heat with you anywhere. That way, everyone who gets them first can immediately start saving on their heat bills.

For the first time ever, portable Amish fireplaces are being delivered directly to the doors of all those who beat the deadline.

These miracle fireplaces have what's being called the 'Fireless Flame' technology that gives you the peaceful flicker of a real fire but without any flames, fumes, smells, ashes or mess. Everyone is getting them because they require no chimney and no vent. You just plug them in.

The Fireless Flame looks so real it fools everybody but it has no real fire. So what's the catch? Well, the soft spoken Amish craftsmen who hand make the mantles are imposing ■ strict household limit of 2 during the strain of the winter rush.

"We can barely keep up ever since we started giving heaters away free. Now that it's really cold outside, everyone's trying to get them. Amish craftsmen are working their fingers to the bone to be sure everyone gets their delivery in time to save a lot of money," confirms Timothy Milton, National Shipping Director.

"These portable Roll-n-Glow Fireplaces are the latest home decorating sensation. They actually give you a beautifully redecorated room while they quickly heat from wall to wall. It's the only way to dress up every room, stay really warm and slash your heat bills all at the same time," says Josette Holland, Home Makeover Expert to the rich and famous.

And here's the best part. Readers who beat the 7 day order deadline are getting their imported hi-tech miracle heaters free when encased in the real Amish built solid wood fireplace mantles. The mantles are being handmade in the USA right in the heart of Amish country where they are beautifully hand-rubbed, stained and varnished.

You just can't find custom made Amish mantles like this in the national chain stores. That makes the solid oak mantle a real steal for just two hundred ninety-eight dollars since the entire cost of the miracle heater is free.

This free giveaway is the best way to slash heating bills and stay warm through the dead of winter. The HEAT SURGE Roll-n-Glow Fireplace gives you all the beauty and warmth of a built-in fireplace but it can also save you a ton of money on heating bills.

Even people in California and Florida are flocking to get them so they may never have to turn on their furnace all winter. And since it uses less energy than a coffee maker the potential savings are absolutely incredible.

"We are making sure no one gets left out, but you better hurry because

How to get 2 free heaters

The National Toll Free Hotlines are now open. All those who beat the 7 day order deadline to cover the Amish made Fireplace Mantles and shipping get the HEAT SURGE miracle heaters free.

They have imposed a strict limit of 2 per household. Since some home woodworkers want to build their own mantle piece, they are letting people get the imported miracle heater alone for just $249. Or, with the Amish made mantle you get the miracle heater free.

Use the map below to locate the weather zone you live in and call the Hotline number for your zone.

Claim Code: FP2193

■ **ON THEIR WAY:** Winter rush orders have turned country roads into pipelines to the big city delivery system. Everybody wants a fireplace that comes fully assembled with a handmade Amish mantle in oak or cherry and gets delivered by truck right to your door. All you do is plug it in.

EVERYONE LIVING IN THE Frigid Zone: 1	EVERYONE LIVING IN THE Cold Zone: 2	EVERYONE LIVING IN THE Frost Zone: 3
START CALLING AT 8:00 A.M. TODAY	START CALLING AT 8:30 A.M. TODAY	START CALLING AT 9:00 A.M. TODAY
1-800-242-6155	1-800-310-7731	1-800-625-7259

HEAT SURGE™ *Fireless* Flame

How It Works: The HEAT SURGE miracle heater is a work of engineering genius from the China coast so advanced, you simply plug it into any standard wall outlet. It uses less energy than it takes to run a coffee maker. Yet, it produces an amazing 5,119 BTU's. An on board Powerful hi-tech heat turbine silently forces hot air out into the room so you feel the bone soothing heat instantly. It even has certification of Underwriters Laboratories coveted UL listing and comes with a full year Money Back Guarantee.

UL LISTED

entire communities of Amish craftsmen are straining to keep up with winter demands. For now, we have to turn away dealers in order to let readers of this magazine have two per household just as long as they call before the deadline," confirms Milton.

It's a really smart decision to get two right now because for only the next 7 days you get both miracle heaters free. That's like putting five hundred bucks right in your pocket and you can save even more money on your monthly heating bills.

"Everyone's calling to get one but those who really want to save a lot on their heating bills are surprising the whole family by getting two. So when lines are busy keep trying or log onto amishfireplaces.com. We promise to get to every call. Then we can have a delivery truck out to your door right away with your beautiful Amish made Roll-n-Glow Fireplace," Milton said.

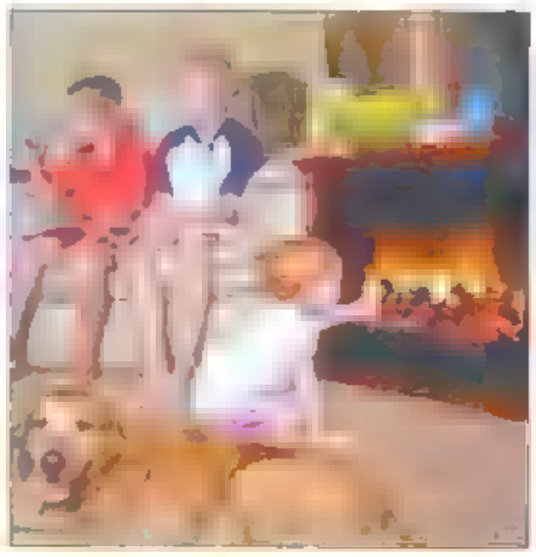
"You'll instantly feel bone soothing heat in any room. You will never have to be cold again," he said. ■

On the worldwide web:
www.amishfireplaces.com

Rolls anywhere to throw an instant heat wave with no chimney, no vents, no wood and no smoke

■ **EASILY ROLLS ANYWHERE:** This is the portable Roll-n-Glow™ Fireplace that easily rolls from bedroom to living room. No vents, no chimney and no tools. Just plug it in.

■ **SAVES ON BILLS:** Everyone gets low bills and stays warm and cozy. Naomi Abrams' new Roll-n-Glow Fireplace saves a ton of money and makes her front room look like a million bucks.



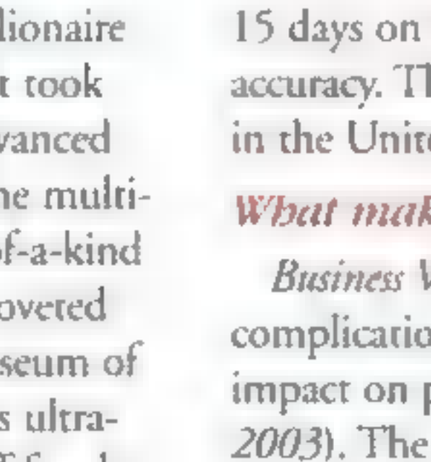
■ **SAFE:** The Fireless Flame looks so real it fools everybody but there is no real fire. That makes it safe to the touch. It's where the kids will play and the cat and dog will sleep.

■ **FREE:** Get this $249 miracle heater free. It is being given away free to all who beat the 7 day order deadline for your choice of the oak or cherry Amish Mantles. The free heater comes already encased.

World's Most Valuable Timepiece Disappears

Back in 1933, the single most important watch ever built was engineered for a quiet millionaire collector named Henry Graves. It took over three years and the most advanced horological technique to create the multi-function masterpiece. This one-of-a-kind watch was to become the most coveted piece in the collection of the Museum of Time near Chicago. Recently this ultra-rare innovation was auctioned off for the record price of $11,030,000 by Sotheby's to a secretive anonymous collector. Now the watch is locked away in a private vault in an unknown location. We believe that a classic like this should be available to true watch aficionados, so Stauer replicated the exact Graves design in the limited edition Graves '33.

The antique enameled face and Bruguet hands are true to the original. But the real beauty of this watch is on the inside. We replicated an extremely complicated automatic movement with 27 jewels and seven hands. There are over 210 individual parts that are assembled entirely by hand and then tested for over 15 days on Swiss calibrators to ensure accuracy. The watches are then reinspected in the United States upon their arrival.



27 jewels and 210 hand-assembled parts drive this classic masterpiece.

What makes rare watches rare?

Business Week states it best…"It's the complications that can have the biggest impact on price." (*Business Week, July, 2003*). The four interior complications on our Graves™ watch display the month, day, date and the 24 hour clock graphically depicts the sun and the moon. The innovative engine for this timepiece is powered by the movement of the body as the automatic rotor winds the mainspring. It never needs batteries and never needs to be manually wound. The precision crafted gears are "lubricated" by 27 rubies that give the hands a smooth sweeping movement. And the watch is tough enough to stay water resistant to 5 atmospheres. The movement is covered by a 2-year warranty.

The face of the original 1930's Graves timepiece from the Museum of Time.

Many fine 27-jewel automatics that are on the market today are usually priced well over $2,000 dollars, but you can enter the rarified world of fine watch collecting for under $100. Try the handsome Graves '33 timepiece risk free for 30 days. If you are not thrilled with the quality and rare design, please send it back for a full refund of the product purchase price.

Not Available in Stores

Call now to take advantage of this limited offer.

Stauer Graves™ '33 Wristwatch or 3 credit card payments of $33 +S&H

800-859-1736

Promotional Code GRV697-04
Please mention this code when you call.

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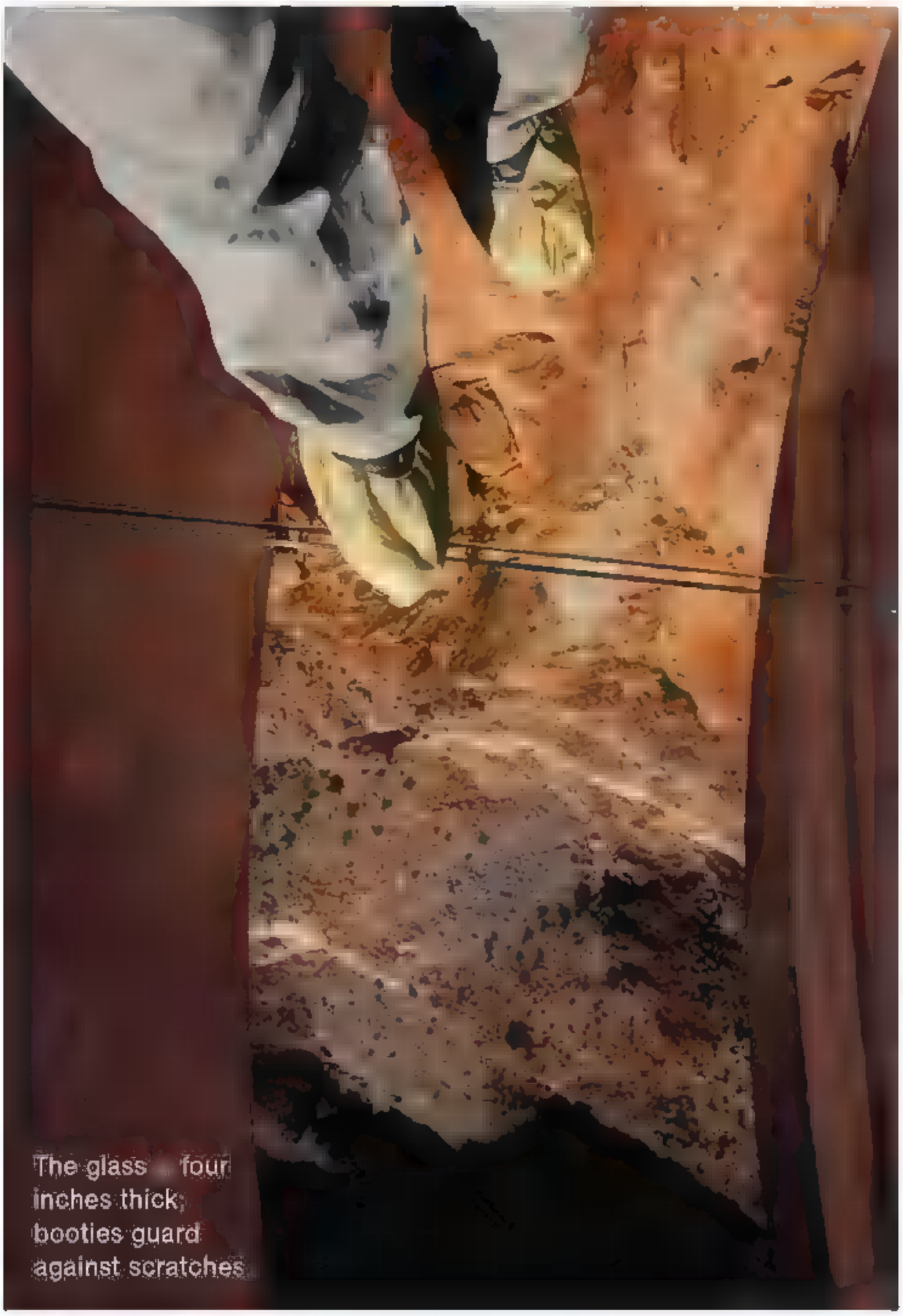
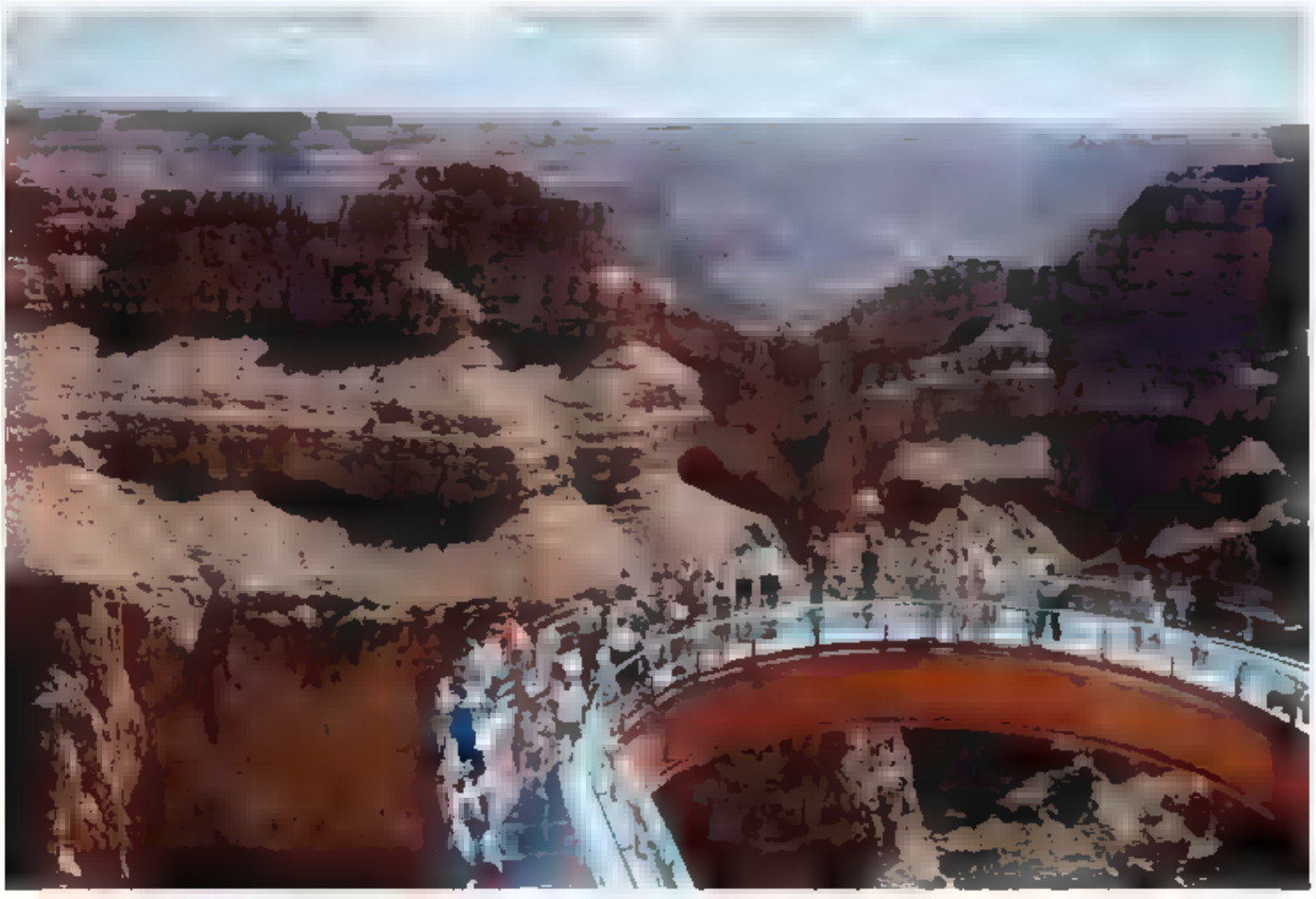


The glass four inches thick; booties guard against scratches



Grand Stand

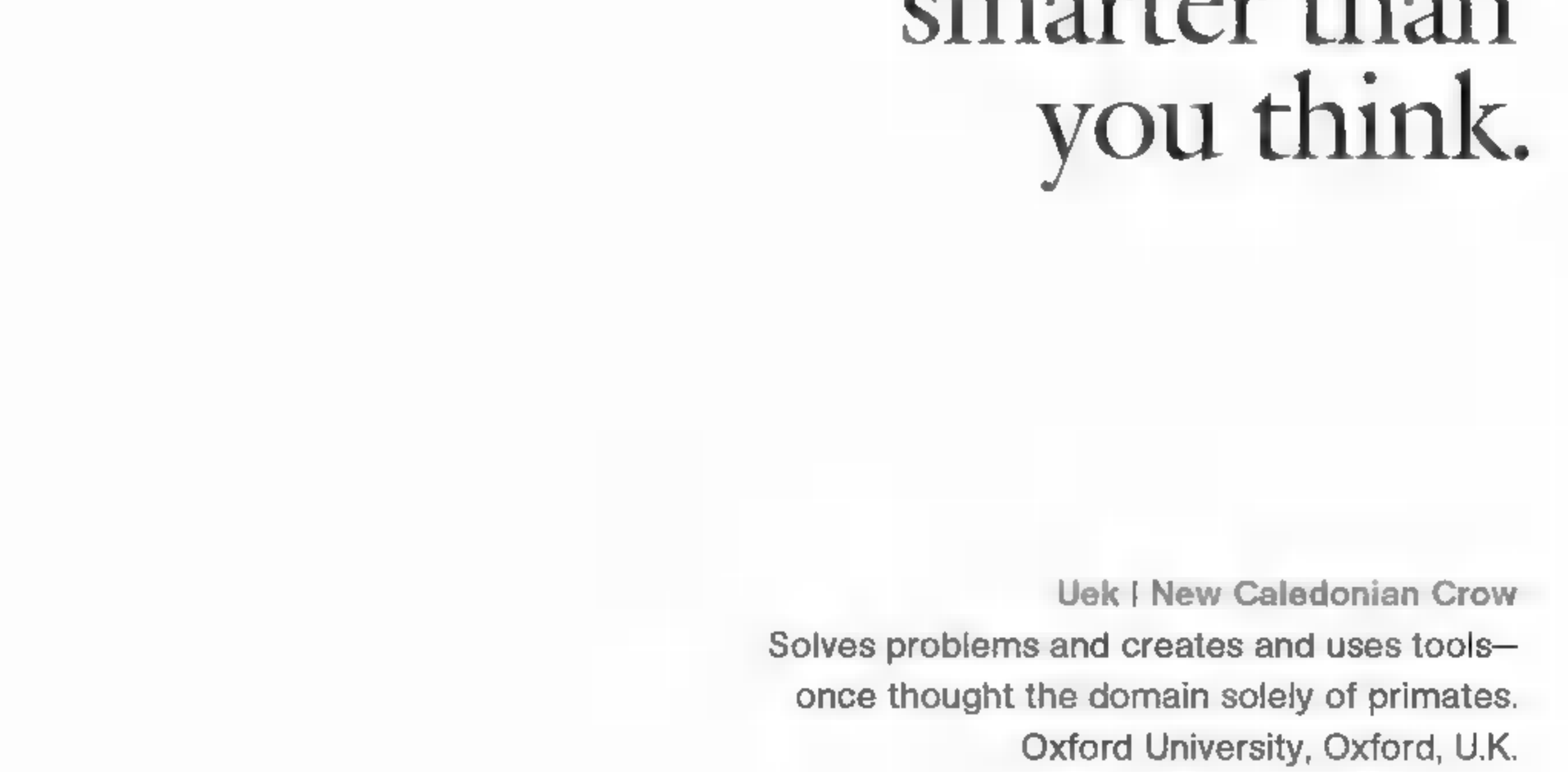
Happy first birthday to Skywalk, the $30-million glass-and-steel horseshoe that juts 4,000 feet above the Grand Canyon floor. Here's a look back—and ahead.

Where it is Not at the popular South Rim, as some folks think, but on Hualapai tribal land, at the canyon's western tip.
Who goes Lots of Vegas day-trippers. A 2.5-hour ride (even with 14 miles of unpaved road) beats 5 hours to the South Rim.
Daily visitors About 1,500.
Cost/benefit Guests pay about $60 to go on Skywalk and tend to stay on it 10 to 15 minutes.
Tourist tactics Scooting; shuffling; leaning boldly on rail.
If uneasy Staff will hold hands, advise "Don't look down."
Too scared to go on No refund.
Gripes A bit pricey; no cameras (lest they be dropped).
Area activities Helicopter ride, river float, off-road tour. Despite requests, no bungee jumps.
Plans Museum, hotel, paved road, VIP lounge (in case Wayne Newton drops by). *—Marc Silver*

PHOTOS: JOHN BURCHAM, NGM MAPS

Minds of their Own

Animals are smarter than you think.



Uek | New Caledonian Crow
Solves problems and creates and uses tools—
once thought the domain solely of primates.
Oxford University, Oxford, U.K.

Azy | Orangutan
Shows cognitive complexity and flexibility rivaling that of chimps; the species maintains cultural traditions in the wild.
Great Ape Trust of Iowa, Des Moines

"AZY HAS A RICH MENTAL LIFE," says Rob Shumaker of his study subject and friend of 25 years. "Orangutans are on equal cognitive footing with African apes, or even surpass them on some tasks." Not only does Azy communicate his thoughts with abstract keyboard symbols, he also demonstrates a "theory of mind" (understanding another individual's perspective) and makes logical, thoughtful choices that show a mental flexibility some chimpanzees lack. In the wild, orangutans keep innovative cultural traditions: Some groups construct foraging tools for extracting insects from tree holes; others use leaves as rain hats or napkins, wad them up as pillows, or line their hands with them when climbing a spiky tree. And in rare instances orangutans will twist leaves into bundles and cradle them like dolls.

—Photo text by Jennifer S. Holland
NATIONAL GEOGRAPHIC STAFF

Shanthi | **Asian Elephant**
Retains long memories and social ties; possesses ■ sense of self.
National Zoo, Washington, DC

African Cichlid
Determines social rank
through observation, a step on
the way to logical reasoning.
Stanford University,
Stanford, CA

WHAT DOES AN ELEPHANT SEE when it looks in the mirror? Itself, apparently—a rare cognitive feat previously known only in humans, apes, and dolphins. Asian elephants in mirror studies first explore the mirror as an object. But on further inspection they may realize they are seeing themselves. They move atypically, watching the show, and will repeatedly touch a mark painted on their heads that they wouldn't see without the mirror. "These are such compelling indications of self-awareness," says Hunter College's Diana Reiss. On a smaller note, in certain African cichlid fish, males watch others fight to size up their competition, and females, when fertile, sidle up to the most active territorial males. Meanwhile, subordinate males may adopt female colors to sneak food from another male's territory. "They can do all this at eight weeks old, with brains the size of a small pea," says Russell Fernald, who studies how social dealings alter the fish's brain cells.

By Virginia Morell
Photographs by Vincent J. Musi

In 1977 Irene Pepperberg,

a recent graduate of Harvard University, did something very bold. At a time when animals still were considered automatons, she set out to find what was on another creature's mind by talking to it. She brought a one-year-old African gray parrot she named Alex into her lab to teach him to reproduce the sounds of the English language. "I thought if he learned to communicate, I could ask him questions about how he sees the world."

When Pepperberg began her dialogue with Alex, who died last September at the age of 31, many scientists believed animals were incapable of any thought. They were simply machines, robots programmed to react to stimuli but lacking the ability to think or feel. Any pet owner would disagree. We see the love in our dogs' eyes and know that, of course, Spot has thoughts and emotions. But such claims remain highly controversial. Gut instinct is not science, and it is all too easy to project human thoughts and feelings onto another creature. How, then, does a scientist prove that an animal is capable of thinking—that it is able to acquire information about the world and act on it?

"That's why I started my studies with Alex," Pepperberg said. They were seated—she at her desk, he on top of his cage—in her lab, a windowless room about the size of a boxcar, at Brandeis University. Newspapers lined the floor; baskets of bright toys were stacked on the shelves. They were clearly a team—and because of their work, the notion that animals can think is no longer so fanciful.

Certain skills are considered key signs of higher mental abilities: good memory, a grasp of grammar and symbols, self-awareness, understanding others'

Alex | African Gray Parrot
Counted; knew colors, shapes, and sizes;
had basic grasp of the abstract concept of zero.
Brandeis University, Waltham, MA

motives, imitating others, and being creative. Bit by bit, in ingenious experiments, researchers have documented these talents in other species, gradually chipping away at what we thought made human beings distinctive while offering a glimpse of where our own abilities came from. Scrub jays know that other jays are thieves and that stashed food can spoil; sheep can recognize faces; chimpanzees use a variety of tools to probe termite mounds and even use weapons to hunt small mammals; dolphins can imitate human postures; the archerfish, which stuns insects with a sudden blast of water, can learn how to aim its squirt simply by watching an experienced fish perform the task. And Alex the parrot turned out to be a surprisingly good talker.

Thirty years after the Alex studies began, Pepperberg and a changing collection of assistants were still giving him English lessons. The humans, along with two younger parrots, also served as Alex's flock, providing the social input all parrots crave. Like any flock, this one—as small as it was—had its share of drama. Alex dominated his fellow parrots, acted huffy at times around Pepperberg, tolerated the other female humans, and fell to pieces over a male assistant who dropped by for a visit. ("If you were a man," Pepperberg said, after noting Alex's aloofness toward me, "he'd be on your shoulder in a second, barfing cashews in your ear.")

Pepperberg bought Alex in a Chicago pet store. She let the store's assistant pick him out because she didn't want other scientists saying later that she'd deliberately chosen an especially smart bird for her work. Given that Alex's brain was the size of a shelled walnut, most researchers thought Pepperberg's interspecies communication study would be futile.

"Some people actually called me crazy for trying this," she said. "Scientists thought that chimpanzees were better subjects, although, of course, chimps can't speak."

Chimpanzees, bonobos, and gorillas have been taught to use sign language and symbols to communicate with us, often with impressive results. The bonobo Kanzi, for instance, carries his symbol-communication board with him so he can "talk" to his human researchers, and he has invented combinations of symbols to express his thoughts. Nevertheless, this is not the same thing as having an animal look up at you, open his mouth, and speak.

Pepperberg walked to the back of the room, where Alex sat on top of his cage preening his pearl gray feathers. He stopped at her approach and opened his beak.

"Want grape," Alex said.

"He hasn't had his breakfast yet," Pepperberg explained, "so he's a little put out."

Alex returned to preening, while an assistant prepared a bowl of grapes, green beans, apple and banana slices, and corn on the cob.

Under Pepperberg's patient tutelage, Alex learned how to use his vocal tract to imitate almost one hundred English words, including the sounds for all of these foods, although he calls an apple a "ban-erry."

"Apples taste a little bit like bananas to him, and they look a little bit like cherries, so Alex made up that word for them," Pepperberg said.

Alex could count to six and was learning the sounds for seven and eight.

"I'm sure he already knows both numbers," Pepperberg said. "He'll probably be able to count to ten, but he's still learning to say the words. It takes far more time to teach him certain sounds than I ever imagined."

After breakfast, Alex preened again, keeping an eye on the flock. Every so often, he leaned forward and opened his beak: "Ssse…won."

"That's good, Alex," Pepperberg said. "Seven. The number is seven."

"Ssse…won! Se…won!"

"He's practicing," she explained. "That's how he learns. He's thinking about how to say that word, how to use his vocal tract to make the correct sound."

"Apples taste a bit like bananas to him, and they look a little bit like cherries, so Alex made up a word for them: 'ban-erry.'"

—IRENE PEPPERBERG

It sounded a bit mad, the idea of a bird having lessons to practice, and willingly doing it. But after listening to and watching Alex, it was difficult to argue with Pepperberg's explanation for his behaviors. She wasn't handing him treats for the repetitious work or rapping him on the claws to make him say the sounds.

"He has to hear the words over and over before he can correctly imitate them," Pepperberg said, after pronouncing "seven" for Alex a good dozen times in a row. "I'm not trying to see if Alex can learn a human language," she added. "That's never been the point. My plan always was to use his imitative skills to get a better understanding of avian cognition."

In other words, because Alex was able to produce a close approximation of the sounds of some English words, Pepperberg could ask him questions about a bird's basic understanding of the world. She couldn't ask him what he was thinking about, but she could ask him about his knowledge of numbers, shapes, and colors. To demonstrate, Pepperberg carried Alex on her arm to a tall wooden perch in the middle of the room. She then retrieved a green key and a small green cup from a basket on a shelf. She held up the two items to Alex's eye.

"What's same?" she asked.

Without hesitation, Alex's beak opened: "Co-lor."

"What's different?" Pepperberg asked.

"Shape," Alex said. His voice had the digitized sound of a cartoon character. Since parrots lack lips (another reason it was difficult for Alex to pronounce some sounds, such as *ba*), the words seemed to come from the air around him, as if a ventriloquist were speaking. But the words—and what can only be called the thoughts—were entirely his.

For the next 20 minutes, Alex ran through his tests, distinguishing colors, shapes, sizes, and materials (wool versus wood versus metal). He did some simple arithmetic, such as counting the yellow toy blocks among a pile of mixed hues.

And, then, as if to offer final proof of the mind inside his bird's brain, Alex spoke up. "Talk clearly!" he commanded, when one of the younger birds Pepperberg was also teaching mispronounced the word green. "Talk clearly!"

"Don't be a smart aleck," Pepperberg said, shaking her head at him. "He knows all this, and he gets bored, so he interrupts the others, or he gives the wrong answer just to be obstinate. At this stage, he's like a teenage son; he's moody, and I'm never sure what he'll do."

"Wanna go tree," Alex said in a tiny voice.

Alex had lived his entire life in captivity, but he knew that beyond the lab's door, there was a hallway and a tall window framing a leafy elm tree. He liked to see the tree, so Pepperberg put her hand out for him to climb aboard. She walked him down the hall into the tree's green light.

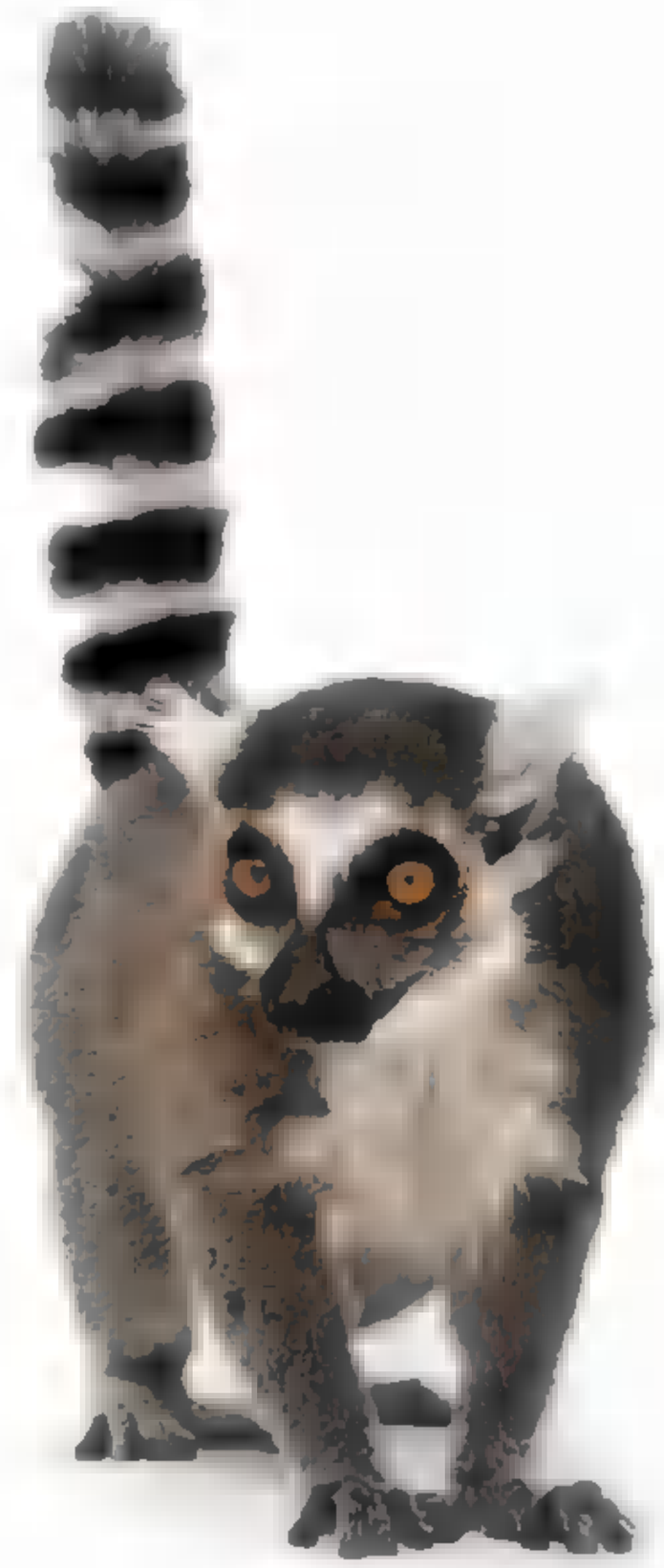
"Good boy! Good birdie," Alex said, bobbing on her hand.

"Yes, you're a good boy. You're a good birdie." And she kissed his feathered head.

He was a good birdie until the end, and Pepperberg was happy to report that when he died he had finally mastered "seven."

Many of Alex's cognitive skills, such as his ability to understand the concepts of same and different, are generally ascribed only to higher mammals, particularly

Edward | Black Leicester Longwool
Sheep recognize individual faces and remember them long term.
Hopping Acres Farm, Bruceton Mills, WV



Aristides | Ring-tailed Lemur
Displays abilities that offer insight into the evolutionary precursors of counting and ordering sequences.
Duke University Lemur Center, Durham, NC

TELL SHEEP THEY ALL LOOK ALIKE, and they may beg to differ. Like primates, sheep, in studies, recognize different faces (about 50 other sheep and 10 humans) and still know them two years later. They are calmed by familiar faces and can tell both happy and angry expressions (they prefer the former). These are sophisticated abilities in an animal not widely known for smarts, says Babraham Institute's Keith Kendrick. How the sheep brain encodes facial identity and emotional cues may be relevant in some human disorders, he says. Ring-tailed lemurs, meanwhile, may be primitive detours off the primate line, but they have impressive numerical abilities. Duke's Elizabeth Brannon reports the animals will repeat arbitrary sequences on a touch screen with their noses and can discriminate between quantities. "They'll do hundreds of trials," she says, getting better over time as they "learn how to learn."

primates. But parrots, like great apes (and humans), live a long time in complex societies. And like primates, these birds must keep track of the dynamics of changing relationships and environments.

"They need to be able to distinguish colors to know when a fruit is ripe or unripe," Pepperberg noted. "They need to categorize things—what's edible, what isn't—and to know the shapes of predators. And it helps to have a concept of numbers if you need to keep track of your flock, and to know who's single and who's paired up. For a long-lived bird, you can't do all of this with instinct; cognition must be involved."

Being able mentally to divide the world into simple abstract categories would seem a valuable skill for many organisms. Is that ability, then, part of the evolutionary drive that led to human intelligence?

Charles Darwin, who attempted to explain how human intelligence developed, extended his theory of evolution to the human brain: Like the rest of our physiology, intelligence must have evolved from simpler organisms, since all animals face the same general challenges of life. They need to find mates, food, and a path through the woods, sea, or sky—tasks that Darwin argued require problem-solving and categorizing abilities. Indeed, Darwin went so far as to suggest that earthworms are cognitive beings because, based on his close observations, they have to make judgments about the kinds of leafy matter they use to block their tunnels. He hadn't expected to find thinking invertebrates and remarked that the hint of earthworm intelligence "has surprised me more than anything else in regard to worms."

To Darwin, the earthworm discovery demonstrated that degrees of intelligence could be found throughout the animal kingdom. But the Darwinian approach to animal intelligence was cast aside in the early 20th century, when researchers decided that field observations were simply "anecdotes," usually tainted by anthropomorphism. In an effort to be more rigorous, many embraced behaviorism, which regarded animals as little more than machines, and focused their studies on the laboratory white rat—since one "machine" would behave like any other.

But if animals are simply machines, how can the appearance of human intelligence be explained? Without Darwin's evolutionary perspective, the greater cognitive skills of people did not make sense biologically. Slowly the pendulum has swung away from the animal-as-machine model and back toward Darwin. A whole range of animal studies now suggest that the roots of cognition are deep, widespread, and highly malleable.

Just how easily new mental skills can evolve is perhaps best illustrated by dogs. Most owners talk to their dogs and expect them to understand. But this canine talent wasn't fully appreciated until a border collie named Rico appeared on a German TV game show in 2001. Rico knew the names of some 200 toys and acquired the names of new ones with ease.

Researchers at the Max Planck Institute for Evolutionary Anthropology in Leipzig heard about Rico and arranged a meeting with him and his owners. That led to a scientific report revealing Rico's uncanny language ability: He could learn and remember words as quickly as a toddler. Other scientists had shown that two-year-old children—who acquire around ten new words a day—have an innate set of principles that guides this task. The ability is seen as one of the key building blocks in language acquisition. The Max Planck scientists suspect that the same principles guide Rico's word learning, and that the technique he uses for learning words is identical to that of humans.

Virginia Morell, a science writer based in Oregon, is a frequent contributor to National Geographic. *Vincent J. Musi lives in South Carolina and shoots diverse topics for* National Geographic *and* Time.

Animals need to find mates, food, and a path through the woods, sea, or sky—tasks that Darwin argued require problem solving.

To find more examples, the scientists read all the letters from hundreds of people claiming that their dogs had Rico's talent. In fact, only two—both border collies—had comparable skills. One of them—the researchers call her Betsy—has a vocabulary of more than 300 words.

"Even our closest relatives, the great apes, can't do what Betsy can do—hear a word only once or twice and know that the acoustic pattern stands for something," said Juliane Kaminski, a cognitive psychologist who worked with Rico and is now studying Betsy. She and her colleague Sebastian Tempelmann had come to Betsy's home in Vienna to give her a fresh battery of tests. Kaminski petted Betsy, while Tempelmann set up a video camera.

"Dogs' understanding of human forms of communication is something new that has evolved," Kaminski said, "something that's developed in them because of their long association with humans." Although Kaminski has not yet tested wolves, she doubts they have this language skill. "Maybe these collies are especially good at it because they're working dogs and highly motivated, and in their traditional herding jobs, they must listen very closely to their owners."

Scientists think that dogs were domesticated about 15,000 years ago, a relatively short time in which to evolve language skills. But how similar are these skills to those of humans? For abstract thinking, we employ symbols, letting one thing stand for another. Kaminski and Tempelmann were testing whether dogs can do this too.

Betsy's owner—whose pseudonym is Schaefer—summoned Betsy, who obediently stretched out at Schaefer's feet, eyes fixed on her face. Whenever Schaefer spoke, Betsy attentively cocked her head from side to side.

Kaminski handed Schaefer a stack of color photographs and asked her to choose one. Each image depicted a dog's toy against a white background—toys Betsy had never seen before. They weren't actual toys; they were only images of toys. Could Betsy connect a two-dimensional picture to a three-dimensional object?

Schaefer held up a picture of a fuzzy, rainbow-colored Frisbee and urged Betsy to find it. Betsy studied the photograph and Schaefer's face, then ran into the kitchen, where the Frisbee was placed among three other toys and photographs of each toy. Betsy brought either the Frisbee or the photograph of the Frisbee to Schaefer every time.

"It wouldn't have been wrong if she'd just brought the photograph," Kaminski said. "But I think Betsy can use a picture, without a name, to find an object. Still, it will take many more tests to prove this."

Even then, Kaminski is unsure that other scientists will ever accept her discovery because Betsy's abstract skill, as minor as it may seem to us, may tread all too closely to human thinking.

Still, we remain the inventive species. No other animal has built skyscrapers, written sonnets, or made a computer. Yet animal researchers say that creativity, like other forms of intelligence, did not simply spring from nothingness. It, too, has evolved.

"People were surprised to discover that chimpanzees make tools," said Alex Kacelnik, a behavioral ecologist at Oxford University, referring to the straws and sticks chimpanzees shape to pull termites from their nests. "But people also thought, 'Well, they share our ancestry—of

"Betsy" | Border Collie
Retains an ever growing
vocabulary that rivals a toddler's.
Vienna, Austria

HOW MUCH THOUGHT goes on behind those eyes? A lot, in this case. Six-year-old "Betsy" can put names to objects faster than a great ape, and her vocabulary is at 340 words and counting. Her smarts showed up early: At ten weeks she would sit on command and was soon picking up on names of items and rushing to retrieve them—ball, rope, paper, box, keys, and dozens more. She now knows at least 15 people by name, and in scientific tests she's proved skilled at linking photographs with the objects they represent. Says her owner, "She's a dog in a human [pack]. We're learning her language, and she's learning ours."

course they're smart.' Now we're finding these kinds of exceptional behaviors in some species of birds. But we don't have a recently shared ancestry with birds. Their evolutionary history is very different; our last common ancestor with all birds was a reptile that lived over 300 million years ago.

"This is not trivial," Kacelnik continued. "It means that evolution can invent similar forms of advanced intelligence more than once—that it's not something reserved only for primates or mammals."

Kacelnik and his colleagues are studying one of these smart species, the New Caledonian crow, which lives in the forests of that Pacific island. New Caledonian crows are among the most skilled of tool-making and tool-using birds, forming probes and hooks from sticks and leaf stems to poke into the crowns of the palm trees, where fat grubs hide. Since these birds, like chimpanzees, make and use tools, researchers can look for similarities in the evolutionary processes that shaped their brains. Something about the environments of both species favored the evolution of tool-making neural powers.

But is their use of tools rigid and limited, or can they be inventive? Do they have what researchers call mental flexibility? Chimpanzees certainly do. In the wild, a chimpanzee may use four sticks of different sizes to extract the honey from a bee's nest. And in captivity, they can figure out how to position several boxes so they can retrieve a banana hanging from a rope.

Answering that question for New Caledonian crows—extremely shy birds—wasn't easy. Even after years of observing them in the wild, researchers couldn't determine if the birds' ability was innate, or if they learned to make and use their tools by watching one another. If it was a genetically inherited skill, could they, like the chimps, use their talent in different, creative ways?

To find out, Kacelnik and his students brought 23 crows of varying ages (all but one caught in the wild) to the aviary in his Oxford lab and let them mate. Four hatchlings were raised in captivity, and all were carefully kept away from the adults, so they had no opportunity to be taught about tools. Yet soon after they fledged, all picked up sticks to probe busily into cracks and shaped different materials into tools. "So we know that at least the bases of tool use are inherited," Kacelnik said. "And now the question is, what else can they do with tools?"

Plenty. In his office, Kacelnik played a video of a test he'd done with one of the wild-caught crows, Betty, who had died recently from an infection. In the film, Betty flies into a room. She's a glossy-black bird with a crow's bright, inquisitive eyes, and she immediately spies the test before her: a glass tube with a tiny basket lodged in its center. The basket holds a bit of meat. The scientists had placed two pieces of wire in the room. One was bent into a hook, the other was straight. They figured Betty would choose the hook to lift the basket by its handle.

But experiments don't always go according to plan. Another crow had stolen the hook before Betty could find it. Betty is undeterred. She looks at the meat in the basket, then spots the straight piece of wire. She picks it up with her beak, pushes one end into a crack in the floor, and uses her beak to bend the other end into a hook. Thus armed, she lifts the basket out of the tube.

"This was the first time Betty had ever seen a piece of wire like this," Kacelnik said. "But she knew she could use it to make a hook and exactly where she needed to bend it to make the size she needed."

They gave Betty other tests, each requiring a slightly different solution, such as making a hook out of a flat piece of aluminum rather than a wire. Each time, Betty invented a new tool and solved the problem. "It means she had a mental representation of what it was she wanted to make. Now that," Kacelnik said, "is a major kind of cognitive sophistication."

This is the larger lesson of animal cognitive research: It humbles us. We are not alone in our ability to invent or plan.

This is the larger lesson of animal cognition research: It humbles us. We are not alone in our ability to invent or plan or to contemplate ourselves—or even to plot and lie.

Deceptive acts require a complicated form of thinking, since you must be able to attribute intentions to the other person and predict that person's behavior. One school of thought argues that human intelligence evolved partly because of the pressure of living in a complex society of calculating beings. Chimpanzees, orangutans, gorillas, and bonobos share this capacity with us. In the wild, primatologists have seen apes hide food from the alpha male or have sex behind his back.

Birds, too, can cheat. Laboratory studies show that western scrub jays can know another bird's intentions and act on that knowledge. A jay that has stolen food itself, for example, knows that if another jay watches it hide a nut, there's a chance the nut will be stolen. So the first jay will return to move the nut when the other jay is gone.

"It's some of the best evidence so far of experience projection in another species," said Nicky Clayton in her aviary lab at Cambridge University. "I would describe it as, 'I know that you know where I have hidden my stash of food, and if I were in your shoes I'd steal it, so I'm going to move my stash to a place you don't know about.'"

This study, by Clayton and her colleague Nathan Emery, is the first to show the kind of ecological pressures, such as the need to hide food for winter use, that would lead to the evolution of such mental abilities. Most provocatively, her research demonstrates that some birds possess what is often considered another uniquely human skill: the ability to recall a specific past event. Scrub jays, for example, seem to know how long ago they cached a particular kind of food, and they manage to retrieve it before it spoils.

Human cognitive psychologists call this kind of memory "episodic memory" and argue that it can exist only in a species that can mentally travel back in time. Despite Clayton's studies, some refuse to concede this ability to the jays. "Animals are stuck in time," explained Sara Shettleworth, a comparative psychologist at the University of Toronto in Canada, meaning that they don't distinguish among past, present, and future the way humans do. Since animals lack language, she said, they probably also lack "the extra layer of imagination and explanation" that provides the running mental narrative accompanying our actions.

Such skepticism is a challenge for Clayton. "We have good evidence that the jays remember the what, where, and when of specific caching events, which is the original definition of episodic memory. But now the goalposts have moved." It's a common complaint among animal researchers. Whenever they find a mental skill in a species that is reminiscent of a special human ability, the human cognition scientists change the definition. But the animal researchers may underestimate their power—it is their discoveries that compel the human side to shore up the divide.

"Sometimes the human cognitive psychologists can be so fixed on their definitions that they forget how fabulous these animal discoveries are," said Clive Wynne of the University of

"Human cognitive psychologists can be so fixed on their definitions that they forget how fabulous these animal discoveries are."

—CLIVE WYNNE

Florida, who has studied cognition in pigeons and marsupials. "We're glimpsing intelligence throughout the animal kingdom, which is what we should expect. It's a bush, not a single-trunk tree with a line leading only to us."

Some of the branches on that bush have led to such degrees of intelligence that we should blush for ever having thought any animal a mere machine.

In the late 1960s a cognitive psychologist named Louis Herman began investigating the cognitive abilities of bottlenose dolphins. Like humans, dolphins are highly social and cosmopolitan, living in subpolar to tropical environments worldwide; they're highly vocal; and they have special sensory skills, such as echolocation. By the 1980s Herman's cognitive studies were focused on a group of four young dolphins—Akeakamai, Phoenix, Elele, and Hiapo—at the Kewalo Basin Marine Mammal Laboratory in Hawaii. The dolphins were curious and playful, and they transferred their sociability to Herman and his students.

"In our work with the dolphins, we had a guiding philosophy," Herman says, "that we could bring out the full flower of their intellect, just as educators try to bring out the full potential of a human child. Dolphins have these big, highly complex brains. My thought was, 'OK, so you have this pretty brain. Let's see what you can do with it.'"

To communicate with the dolphins, Herman and his team invented a hand- and arm-signal language, complete with a simple grammar. For instance, a pumping motion of the closed fists meant "hoop," and both arms extended overhead (as in jumping jacks) meant "ball." A "come here" gesture with a single arm told them to "fetch." Responding to the request "hoop, ball, fetch," Akeakamai would push the ball to the hoop. But if the word order was changed to "ball, hoop, fetch," she would carry the hoop to the ball. Over time she could interpret more grammatically complex requests, such as "right, basket, left, Frisbee, in," asking that she put the Frisbee on her left in the basket on her right. Reversing "left" and "right" in the instruction would reverse Akeakamai's actions. Akeakamai could complete such requests the first time they were made, showing a deep understanding of the grammar of the language.

"They're a very vocal species," Herman adds. "Our studies showed that they could imitate arbitrary sounds that we broadcast into their tank, an ability that may be tied to their own need to communicate. I'm not saying they have a dolphin language. But they are capable of understanding the novel instructions that we convey to them in a tutored language; their brains have that ability.

"There are many things they could do that people have always doubted about animals. For example, they correctly interpreted, on the very first occasion, gestured instructions given by a person displayed on a TV screen behind an underwater window. They recognized that television images were representations of the real world that could be acted on in the same way as in the real world."

They readily imitated motor behaviors of their instructors too. If a trainer bent backward and lifted a leg, the *(Continued on page 60)*

JB | Giant Pacific Octopus
Has distinct personality, uses tools, recognizes individuals.
National Aquarium in Baltimore, MD

With sizable brains and dexterous arms, octopuses are known to block their dens with rocks and amuse themselves shooting water at plastic-bottle targets (the first reported invertebrate play behavior) and at lab staff. They may even express basic emotions by changing color, says Seattle Aquarium's Roland Anderson.

Kanzi | Bonobo
Acquired language spontaneously;
makes tools at level of early humans.
Great Ape Trust of Iowa, Des Moines

YOUNG KANZI began picking up language on his own—observing scientists trying to train his mother. At 27, the bonobo "talks" using more than 360 keyboard symbols and understands thousands of spoken words. He forms sentences, follows novel instructions, and crafts stone tools—altering his technique depending on a stone's hardness. He even plays piano (he once jammed with Peter Gabriel). Lodge us together with bonobos for 15 generations, says Great Ape Trust's William Fields, and "the bonobos would become less bonobo, the people less human. We aren't really that different." Case in point, Fields is now analyzing Kanzi's vocalizations: "We think he may be speaking English words, just too fast and high-pitched for us to decode."

Momo | Marmoset
Learns from and imitates others.
University of Vienna, Austria

DON'T LET THE WALNUT-SIZE BRAIN fool you. Western scrub jays (right) do some real reasoning, says University of Cambridge professor Nicky Clayton. They will move a food cache if another jay sees them hide it, recalling when they themselves were thieves. Clayton says jays also spontaneously plan for tomorrow's breakfast, basing food stores on future hunger regardless of current needs. Common marmosets, as infants, learn what to eat by watching elders and, like apes, can imitate others' actions—one of the most complex forms of learning. (They even have ■ sense of "object permanence"—knowing that something out of sight still exists.) But, says Friederike Range of the University of Vienna, the primates' short attention spans may keep them from developing more complex behaviors.

Psychobird | **Western Scrub Jay**
Recalls the past,
plans for the future.
Cambridge University,
Cambridge, U.K.

> "A dolphin has this big, highly complex brain. My thought was, 'OK, let's see what you can do with it.'"
>
> —LOUIS HERMAN

dolphin would turn on its back and lift its tail in the air. Although imitation was once regarded as a simpleminded skill, in recent years cognitive scientists have revealed that it's extremely difficult, requiring the imitator to form a mental image of the other person's body and pose, then adjust his own body parts into the same position—actions that imply an awareness of one's self.

"Here's Elele," Herman says, showing a film of her following a trainer's directions. "Surfboard, dorsal fin, touch." Instantly Elele swam to the board and, leaning to one side, gently laid her dorsal fin on it, an untrained behavior. The trainer stretched her arms straight up, signaling "Hooray!" and Elele leaped into the air, squeaking and clicking with delight.

"Elele just loved to be right," Herman said. "And she loved inventing things. We made up a sign for 'create,' which asked a dolphin to create its own behavior."

Dolphins often synchronize their movements in the wild, such as leaping and diving side by side, but scientists don't know what signal they use to stay so tightly coordinated. Herman thought he might be able to tease out the technique with his pupils. In the film, Akeakamai and Phoenix are asked to create a trick and do it together. The two dolphins swim away from the side of the pool, circle together underwater for about ten seconds, then leap out of the water, spinning clockwise on their long axis and squirting water from their mouths, every maneuver done at the same instant. "None of this was trained," Herman says, "and it looks to us absolutely mysterious. We don't know how they do it—or did it."

He never will. Akeakamai and Phoenix and the two others died accidentally four years ago. Through these dolphins, he made some of the most extraordinary breakthroughs ever in understanding another species' mind—a species that even Herman describes as "alien," given its aquatic life and the fact that dolphins and primates diverged millions of years ago. "That kind of cognitive convergence suggests there must be some similar pressures selecting for intellect," Herman said. "We don't share their biology or ecology. That leaves social similarities—the need to establish relationships and alliances superimposed on a lengthy period of maternal care and longevity—as the likely common driving force."

"I loved our dolphins," Herman says, "as I'm sure you love your pets. But it was more than that, more than the love you have for a pet. The dolphins were our colleagues. That's the only word that fits. They were our partners in this research, guiding us into all the capabilities of their minds. When they died, it was like losing our children."

Herman pulled a photograph from his file. In it, he is in the pool with Phoenix, who rests her head on his shoulder. He is smiling and reaching back to embrace her. She is sleek and silvery with appealingly large eyes, and she looks to be smiling too, as dolphins always do. It's an image of love between two beings. In that pool, at least for that moment, there was clearly a meeting of the minds. □

Getting Into Their Heads Vince Musi introduces the animals he photographed and recounts the challenges he faced making their portraits, at **ngm.com.**

Maya | Bottlenose Dolphin
Excels at communication and imitative behavior.
National Aquarium in Baltimore, MD

Master mimics with long memories, ■ tight grasp of vocabulary and syntax, and ■ creative streak, dolphins are cognitively and behaviorally flexible. Says University of Hawaii's Louis Herman, "They have big generalist brains like we do. They'll manipulate their world to make things possible."

Meltwater from Iceland's largest glacier thunders into a canyon, drawing tourists to the precipice. Until now most raging rivers like this—a huge potential source of hydroelectric power—have remained wild.

POWER STRUGGLE

THE PEOPLE OF ICELAND AWAKEN TO A STARK CHOICE: EXPLOIT A WEALTH OF CLEAN ENERGY OR KEEP THEIR LANDSCAPE PRISTINE.

BY MARGUERITE DEL GIUDICE PHOTOGRAPHS BY JONAS BENDIKSEN

The 650 foot high Karahnjukar Dam blocked the Lagarfljot River in 2003, flooding 22 square miles to generate electricity for a new Alcoa aluminum smelter in the east Iceland town of Reydarfjordur. The project has polarized conservation and industrial interests in Iceland.

One of the main things to understand about Iceland is how tiny the population is and what it can be like to live here because of that. There's the feeling that everybody on this isolated subarctic island knows just about everybody else, or at least can be associated (through family, friends, neighborhood, profession, political party, or school) by no more than one degree of separation. Imagine a country of 310,000 people, with most of them jammed in and around Reykjavík—a hip European capital known for its dimly lit coffeehouses, live music, and hard-drinking nightlife. That's where all the good jobs are, and the chances of running into somebody you know are so high that it's hard, as one commentator mused, to have a love affair without getting caught.

"We are," said one bespectacled sixtysomething newspaper editor wearing a blazing white shirt, "very close-knit." Then he clasped his hands together, as if in an embrace. Or a vise.

The consequence of living in what amounts to a small town on an island in the middle of nowhere, with its vertiginous links going back dozens of generations to the origins of Viking myth (a gene pool so pure that molecular biologists drool), is that it functions somewhat like a big extended family. "As soon as you open your mouth," one observer said, "they're all over you." It's like living on a mobile—disturbing any part of it could generate a ripple throughout. So while Iceland in many ways remains an open and transparent society, there's an underlying guardedness among the people when it comes to talking politics and public policy—concerning such things as how the country should go about striking a balance between protecting its environment and growing its economy, which is more or less what this story is about.

Marguerite Del Giudice wrote about a grueling Arctic trek in the January 2007 issue. Jonas Bendiksen photographed Dharavi, a slum in India, in May.

Young people reunite each summer in the eastern village of Bakkagerði, where they once worked in the fish factory. Hallveig Karlsdóttir (at center, in glasses), who now works in a bakery in the capital of Reykjavik, says that though she and her friends miss the camaraderie of village life, "we can't find good jobs here."

"WE ARE," SAID ONE BESPECTACLED SIXTY-SOMETHING NEWSPAPER EDITOR, "VERY CLOSE-KNIT." THEN HE CLASPED HIS HANDS TOGETHER, AS IF IN AN EMBRACE. OR A VISE.

"THE DROWNING"

In the fall of 2006, secluded, faraway Iceland found itself at a turning point. A remote highland wilderness was being flooded—this to create a reservoir measuring 22 square miles as a power source for a new aluminum smelter. The dam that went with the reservoir was the tallest of its kind in Europe (the continent Iceland is conventionally associated with), and the land was going to be irreversibly changed: highland vegetation submerged, waterfalls and part of a dramatic canyon dried up, pink-footed geese and reindeer herds displaced. Environmentalists around the world were condemning the flooding as an attack on one of Europe's last intact wilderness areas—they called it "the drowning"—and the Icelanders themselves didn't know if they were headed for an economic boom, an economic bust, and/or the greatest environmental disaster in European history.

But that's getting ahead of things. This modern Icelandic saga actually begins millions of years ago, for it is rooted in the land itself—the island's unique geology and the geologic destiny that issues from it. First of all, the country is largely uninhabitable—a rocky, windswept,

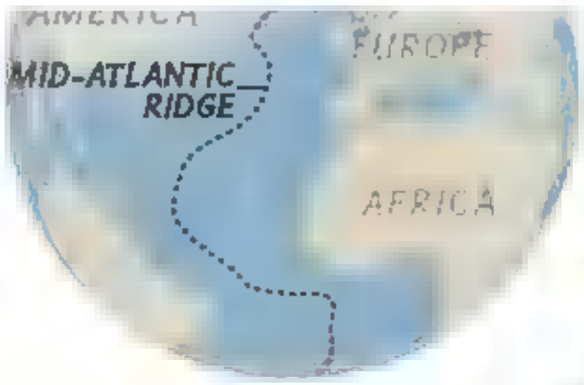
Iceland's highest paying jobs and two-thirds of its people are packed in and around Reykjavík (opposite), the only city and the center for environmental activism. Aluminum-sided apartments house students from the countryside. Since the construction of the smelter on the east coast, a few young people have headed back there.

treeless terrain, unsuitable for much of anything beyond raising sheep. "Forbidding" comes to mind. Breathtaking. Strange. Giant chunks of blue ice floating in glacial lakes edged with boiling mud. Craggy mountains with formations that resemble human heads. Volcanoes, geysers, glaciers, belching gas vents, and vast stretches of gnarly lava fields where American astronauts came in the 1960s to see what they would be up against on the moon.

Here's where geologic destiny comes in. Iceland happens to be situated right on top of the intersection of two of Earth's tectonic plates, straddling a volcanic boundary called the Mid-Atlantic Ridge. Consequently, a third of all the lava that has erupted from the Earth in the past 500 years has flowed out right here, and there are so many natural hot springs that almost all the homes and buildings are heated geothermally. On the surface, meanwhile, sit giant glaciers and the abundant rivers that flow from them. This hot-and-cold combination, of churning activity beneath the surface and powerful rivers above it, makes Iceland one of the most concentrated sources of geothermal and hydroelectric energy on Earth—clean, renewable, green energies that the world increasingly hungers for.

The thing is, very little of that energy has been tapped, because it's stranded in the middle of the nowhere between continental Europe and Greenland. So, since the 1960s, the government has been wooing heavy industry to Iceland with the promise of cheap electricity, no red tape, and minimal environmental impact. But—except for two small smelters and a ferrosilicon plant—getting companies to come here has been a hard sell. The labor force is very small, highly paid, and probably overeducated. Add to that the remoteness of the place, the long, dark winters, and the inhospitable weather. Only an industry requiring the most intensive use of energy, and which could get a heckuva good rate for it over a long period, would find it economical to set up shop all the way in Iceland. The most obvious fit was the aluminum industry. And so it was—to the alarm of environmentalists who want to save that rare land and the thrill of industrialists who want to use some of it to finally produce something—that the paths of aluminum smelting and unspoiled Iceland were fated to cross.

According to Sigurður Arnalds, the spokesman for Landsvirkjun, the national power company—an avuncular engineer everyone calls "Siggi," whose hooded *(Continued on page 74)*



Sea

Ísafjörður

DYNJANDI NATURAL MONUMENT

VATNSFJÖRÐUR NATURE RESERVE

Sauðárkrókur

MIKLAVATN NATURE RESERVE

BÚÐAHRAUN NATURE RESERVE

I C E

GEITLAND NATURE RESERVE

GRUNDARTANGI FERROSILICON SMELTER

GREENFIELD SMELTER (EXPANDING)

Miðsandur

Akranes

Hvalfjörður

THINGVELLIR N.P.

Reykjavík

Kópavogur

HELGUVÍK SMELTER (APPROVED)

Hafnarfjörður

Keflavík

STRAUMSVÍK SMELTER

Hveragerði

BLÁFJÖLL COUNTRY PARK

HELLISHEIÐI GEOTHERMAL PLANT

REYKJANES COUNTRY PARK

HERDÍSARVÍK N.R.

Grindavík

Vestmannaeyjar

0 mi 20

0 km 20

WILD—FOR HOW LONG?

Only 100,000 people live outside Reykjavik, most in scattered coastal villages that are dying out as family-owned fishing businesses decline. Advocates of aluminum smelting say such development is needed to reinvigorate the rural regions, while environmentalists press for new national parks to support tourism, the fastest growing industry. Last year the government created Vatnajökull National Park (purple) to offset wilderness lost to Kárahnjúkar (orange), though most of it is ice.

MAP BY HANS H. HANSEN, FIXLANDA EHF. SOURCES: ORKUSTOFNUN AND ICELAND GEOSURVEY. M. BRODY DITTEMORE, NGM MAPS

BOUNDARIES OF VATNAJÖKULL NATIONAL PARK

HÚSAVÍK SMELTER (PROPOSED)

Húsavík

Dalvík

Akureyri

Kambhorn

VESTMANNSVATN NATURE RESERVE

JÖKULSÁRGLJÚFUR NATIONAL PARK

Skjálfandafljót

Mývatn

MÝVATN-LAXÁ CONSERVATION AREA

HERÐUBREIÐ NATURE RESERVE

ASKJA NATURAL MONUMENT

KÁRAHNJÚKAR DAM

Kárahnjúkar

HVANNALINDIR N.R.

KRINGILSÁRRANI N.R.

AREA AFFECTED BY THE KÁRAHNJÚKAR PROJECT

Direction of dam-related ocean impact

Bakkagerði

Jökulsá á Dal

Seyðisfjörður

Egilsstaðir

Reyðarfjörður

FJARÐAÁL SMELTER

LÓNSÖRÆFI N.R.

THJÓRSÁRVER NATURE RESERVE

Vatnajökull

SKAFTAFELL NATIONAL PARK

ESJUFJÖLL NATURE RESERVE

LAKAGÍGAR NATURAL MONUMENT

Hvannadalshnúkur
6,952 ft. 2,119 m

FJALLABAK NATURE RESERVE

ALFTAVERSGÍGAR NATURAL MONUMENT

Höfn

ATLANTIC OCEAN

L A N D

KÁRAHNJÚKAR INFRASTRUCTURE

- Dam
- Power plant
- Smelter
- Electrical lines
- -- Tunnel

AREAS OF GREATEST GEOTHERMAL ENERGY POTENTIAL

YOUNG BEDROCK

ENERGY POTENTIAL

Iceland sits astride the Mid-Atlantic Ridge, a volcanic rift between the North American and Eurasian plates. Underground water heated by molten rock warms 90 percent of homes, and glacial rivers can be dammed for hydroelectricity.

Alcoa located its power-hungry smelter at Reydarfjördur to exploit low-cost electricity from Kárahnjúkar Dam. The company also received a waiver of limits on greenhouse gas emissions. Refined bauxite ore is imported from the tropics; finished aluminum is shipped mainly to Europe.

AS THE PROJECT PROGRESSED, IT BECAME CLEAR THAT KÁRAHNJÚKAR WAS BIGGER THAN ANYONE HAD IMAGINED. A KIND OF NATIONAL FAMILY FEUD ERUPTED.

eyes and white-fringed balding head give him the same soft appeal as Mr. Magoo—the grand idea was to "export electrical power on ships in the form of aluminum."

"WE HAVE TO LIVE"

Now elsewhere in the world, Iceland may be spoken of, somewhat breathlessly, as western Europe's last pristine wilderness. But the environmental awareness that is sweeping the world had bypassed the majority of Icelanders. Certainly they were connected to their land, the way one is complicatedly connected to, or encumbered by, family one can't do anything about. But the truth is, once you're off the beaten paths of the low-lying coastal areas where everyone lives, the roads are few, and they're all bad, so Iceland's natural wonders have been out of reach and unknown even to its own inhabitants. For them the land has always just been there, something that had to be dealt with and, if possible, exploited—the mind-set being one of land as commodity rather than land as, well, priceless art on the scale of the "Mona Lisa."

When the opportunity arose in 2003 for the national power company to enter into a 40-year contract with the American aluminum company Alcoa to supply hydroelectric power for a new smelter, those who had been dreaming of something like this for decades jumped at it and never looked back. Iceland may at the moment be one of the world's richest countries, with a 99 percent literacy rate and long life expectancy. But the project's advocates, some of them getting on in years, were more emotionally attuned to the country's century upon century of want, hardship, and colonial servitude to Denmark, which officially had ended only in 1944 and whose psychological imprint remained relatively fresh. For the longest time, life here had meant little more than a sod hut, dark all winter, cold, no hope, children dying left and right, earthquakes, plagues, starvation, volcanoes erupting and destroying all vegetation and livestock, all spirit—a world revolving almost entirely around the welfare of one's sheep and, later, on how good the cod catch was. In the outlying regions, it still largely does.

Ostensibly, the Alcoa project was intended to save one of these dying regions—the remote and sparsely populated east—where the way of life had steadily declined to a point of desperation and gloom. After fishing quotas were imposed in the early 1980s to protect fish stocks, many individual boat owners sold their allotments or gave them away, fishing rights ended up mostly in the hands of a few companies, and small fishermen were virtually wiped out. Technological advances drained away even more jobs previously done by human hands, and the people were seeing everything they had worked for all their lives turn up worthless and their children move away. With the old way of life doomed, aluminum projects like this one had come to be perceived, wisely or not, as a last chance. "Smelter or death."

The contract with Alcoa would infuse the region with foreign capital, an estimated 400 jobs, and spin-off service industries. It also was a way for Iceland to develop expertise that potentially could be sold to the rest of the world; diversify an economy historically dependent on fish; and, in an appealing display of Icelandic can-do verve, perhaps even protect all of Iceland, once and for all, from the unpredictability of life itself.

"We have to live," Halldór Ásgrímsson said in his sad, sonorous voice. Halldór, a former prime minister and longtime member of parliament from the region, was a driving force behind the project. "We have a right to live."

THE LITTLE COUNTRY THAT COULD

At first, most of the country appeared to be behind the dam and smelter that would save the east—it would be good for Iceland, progressive, modern. As far as Icelanders are concerned, Iceland is the greatest country on Earth and everything Icelandic is the best. "We are like Tarzan, a proud island nation," remarked a man who directs a whale museum. They pride themselves

Activists unfurl a banner at the Grundartangi smelter, denouncing an expansion that will increase its power demands and its output of pollutants such as sulfur dioxide. Despite fierce opposition, a new smelter is to be built in Helguvík, and another is planned near Húsavík.

on the sagas, the absorbing, rambling, medieval narratives of early Norse and Icelandic society that are generally considered among the Middle Ages' finest literature; a Nobel laureate for literature (Halldór Laxness in 1955); three Miss Worlds; four climbers of Everest; the oldest parliament extant; and the world's first democratically elected female president, Vigdís Finnbogadóttir, who served for 16 years before she'd had enough.

In any event, the national power company was spending 1.5 billion dollars on the hydroelectric part of the dam-and-smelter project, most of it borrowed from international banks—the biggest construction investment little Iceland had ever undertaken and probably ever would. The energy expected to be generated annually (4,600 gigawatt-hours) was about half what the entire nation was then using, and the scale of it was intoxicating: a huge tangle of dams, tunnels, power stations, and high-tension lines, including one rock-and-gravel dam 650 feet high.

All this to service the single aluminum smelter being built on the other side of the country from Reykjavík, in the eastern fjord town of Reyðarfjörður, which is pronounced something like "radar-f'your-dur." There's an unremarkable mountain out there named Kárahnjúkar, and that's where they got the name for what they were doing: the Kárahnjúkar Hydroelectric Project. You say it "KAR-en-yoo-kar."

As the project progressed, it gradually became clear that Kárahnjúkar was bigger than anyone had imagined. Even Jóhann Kröyer, project manager for the dams and tunnels, remarked over dinner at a work-site canteen: "I think maybe people didn't realize how huge this project is."

But as the months passed, a growing and significant minority did realize it, and a kind of national family feud erupted—ostensibly framed around the irreversible impact on the land of the gigantic dam, the blocking of two glacial rivers, and the resultant flooding of the highland wilderness for the reservoir. Iceland had obtained an exemption from the Kyoto Protocol pollution limits, which would *(Continued on page 82)*

Molten lava flowing across wetlands and into the cold waters of Lake Mývatn set off steam explosions that created a chain of pseudo craters more than 2,000 years ago—a landscape that draws sightseers today.

Glacial melt and subterranean fire define Iceland. A millennium ago they inspired a pagan poem's end-of-the-world vision: "The sun turns black, earth sinks in the sea, the hot stars from heaven are whirled; fierce grows the steam and the life-feeding flame, till fire leaps high about heaven itself."

WITH THE OLD WAY OF LIFE DOOMED, ALUMINUM PROJECTS LIKE THIS ONE HAD COME TO BE PERCEIVED, WISELY OR NOT, AS A LAST CHANCE. "SMELTER OR DEATH."

expire in 2012, adding an element of urgency, and future smelters and expansions were on the drawing board. Was the government going to take one of the world's cleanest countries and offer it up as a dumping ground for heavy industry?

Did the people really want this—did they even understand what it meant?

PLANETARY DIFFERENCES

Kárahnjúkar touched off what one player characterized as Iceland's cold war. A leading conservationist said to me, for instance, that when he walks by a river, he sees an act of God, and that when dambuilders walk by, "they start counting kilowatt-hours." Told of the remark, a smelter manager sniffed, "They don't understand business, and they don't want to."

One side may as well have been from Venus and the other from Mars.

The main guy here from Alcoa, Tómas Már Sigurđsson, a native Icelander with a degree in environmental engineering who considers himself an environmentalist, was upbeat and idealistic. Alcoa's mission, he said, was to be a good neighbor in the community—while creating the most efficient, safe, and eco-friendly smelter on the planet, by recycling materials and using state-of-the-art technologies to minimize waste and control the sulfur dioxide fumes that are a by-product of smelting aluminum from alumina, a white powder refined from bauxite ore.

He seemed particularly psyched about something Alcoa calls the Sustainability Initiative—under which representatives of diverse interest groups (business, government, the power company, community, church, the environment) devise mutually agreed-on standards for holding Alcoa accountable over time: Did Alcoa raise the region's standard of living, provide the kinds of jobs it said it would, treat the environment as promised? The Sustainability Initiative had been put into effect at the new smelter in Reyđarfjörđur. "A first in the world," Tómas said—and an industry template for how to approach new communities with the controversial idea of building smelters.

"We're not just building a factory that will produce metal," said Tómas, baby-faced, balding, and fit, with high color, a smear of lips, and an open, earnest manner. "It's a far different level."

Young and idealistic eco-warriors, meanwhile, rolled their eyes in droll disbelief. They dismissed things like the Sustainability Initiative as little more than a capitalist lie designed to manipulate and co-opt an unsuspecting public—a "greenwash," as they put it, which is why, in one highly publicized protest action, a band of them dumped buckets of green-dyed yogurty stuff, called skyr (pronounced skeer), on a gathering of aluminum industrialists (including Alcoa's Tómas), who, not realizing at the time that the skyr was just skyr, were understandably alarmed. "They were trying to say aluminum smelters were eco-friendly!" said Arna Ösp Magnúsardóttir, a local protest organizer who got arrested that day, as she sat at a sidewalk café in Reykjavík, wearing a pink satin pajama top over black tights.

She conceded that she hadn't really thought skyr was going to stop Kárahnjúkar.

"For me, it's to stop future projects and to hassle them enough that they know they won't get away with this again so easily."

Kárahnjúkar's critics argued that surely something else could have been done to help the east without messing so much with the land. Building something on the scale of Kárahnjúkar to solve things, as one man put it, was like "taking a heartbroken kid and giving him a triple-bypass operation."

At the same time, the people in the east said they had tried everything they could think of—business, industry, tourism. "Nothing worked," said Smári Geirsson, a high school history teacher and onetime head of the 16-member association of eastern municipalities. What he said next beat at the heart of Iceland's cold war: "I think the people who are against this are very worried about the land and the reindeer and the birds. But they never want to discuss the needs

of the people. Many live in Reykjavík, and they are against it if we move a stone here," he said, pinching his fingers together as if holding one. "But they live in concrete and asphalt. They want to come here in their Jeeps and have a look at the beautiful nature and the people too. And the people must be few and the more strange the better," he said, shaking his bowed head.

This clash of ideals can be traced to the early 20th century, when Iceland was still poor as dirt and romantic poetry was being written about the harnessing of the waterfalls as the future of Iceland. During and after World War II, the occupation by thousands of British and then American soldiers led to a massive influx of foreign capital and an investment in some fishing trawlers, which boosted the economy for a while. Then over time the fish stocks declined, the herring disappeared, and Iceland became poor again.

By the mid-1960s, according to Styrmir Gunnarsson, the snowy-haired editor of Reykjavík's leading daily, *Morgunbladid,* the mood of the country was shifting back to the idea of becoming well-off "by using waterfalls to produce electricity and also by having aluminum factories." So decade after decade, driven by a desire to build a leg other than fish for Iceland to stand on—and "inspired by the idealism of it" and by the poetry, Styrmir said—the society went about creating an infrastructure. Government agencies, ministries, academic departments, financial institutions, engineering firms—all in pursuit of what was thought of as a big and beautiful idea. Then, over the past two decades, the mood of the country again began to shift.

Little by little, Icelanders and eco-trekkers from around the world started venturing into the interior wilderness, he said, and a belated awareness of what was there—"glaciers, black sand, beautiful blue rivers"—began to take hold. "As the population has traveled to these parts, all get the same feeling: You shouldn't change it. No power dams, no roads. It should be just as it is."

In the midst of this environmental awakening, the opportunity with Alcoa stood as possibly the last chance for many Icelanders to realize a century-long industrial dream.

"They felt they were doing something good for the nation," Styrmir said.

Now that they're being depicted as environmental criminals, they're bewildered.

"They don't understand."

THE SKY IS FALLING

The months passed, and protests mounted. A protest camp and a protest concert were held, featuring Björk, the waif rock chanteuse who is currently Iceland's most famous export; upwards of 10,000 people marched in downtown Reykjavík days before the flooding of the reservoir (the equivalent of ten million-plus people showing up someplace in the U.S.); and state television's Ómar Ragnarsson, Iceland's most famous reporter, a completely bald and preternaturally energetic 67-year-old (known for flying his Cessna to the sites of erupting volcanoes and sleeping in his black Jeep when he had to, surviving on Cheerios and Coca-Cola), launched a 20-foot white fiberglass boat he dubbed *The Ark* into the reservoir, to collect samples of lost vegetation and stone as it filled over the months and to film the land as it was transformed.

Critics, meanwhile, picked away at Kárahnjúkar's business plan and characterized it, in a variety of ways, as crazy. The borrowed 1.5 billion dollars, for instance, was to be paid off with revenue from Alcoa over the four-decade contract. After that, Siggi, the power company spokesman, predicted, the dam would be "a gold mine"—a rosy forecast not shared by those who had started to think twice about there being no direct return for 40 years on such a huge investment.

And what about the geologic risks associated with boring and blasting 45 miles of tunnels in a country that was one big volcano? Siggi insisted that the dam wasn't located in an earthquake zone but nonetheless had been designed to withstand heavy shocks, and he likened all the

FOR THE LONGEST TIME, LIFE HAD MEANT LITTLE MORE THAN A SOD HUT, DARK ALL WINTER, COLD, CHILDREN DYING LEFT AND RIGHT, EARTHQUAKES, PLAGUES, VOLCANOES.

safety measures taken to "putting many, many belts on the same pair of trousers."

But would the electromagnetic fields emanating from the project's 31 miles of high-tension power lines make people sick? And how about pollution from the smelter? Alcoa's plan was to blast potentially acid-rain-producing sulfur dioxide fumes way out into the atmosphere through a giant chimney. But what if the fumes became caught in the fjord's notoriously calm atmosphere, trapped between mountains?

Inevitably, it started to dawn on more and more people: The entire public was paying for this grand project and would be responsible if something went wrong, but the benefits were accruing only to one depressed region numbering several thousand people. There began to be grumblings about Iceland's "old boy" political party system and the perceived lack of forthrightness in engaging the electorate about the country's industrial policy.

"On the surface, we have an open debate," said Baldur Þórhallsson, a professor at the University of Iceland who specializes in the politics of small societies. "But underneath, there is this tendency by some politicians to control the

From the house he was born in, Jónas Bjarnason (opposite) looks with sadness toward fields where his son's sheep graze above a magnificent fjord near Húsavík. A proposed smelter would block the view and force the family to pasture them elsewhere. Crisscrossing the land, pipes carry steam to the Hellisheiði geothermal plant to generate power.

debate and the agenda . . . phone calls, emails, and letters making little indirect threats." With job opportunities few in such a small place—and ties among politics, business, government, and media so Byzantine that conflicts of interest are impossible to avoid and sleeping with the enemy is literally true—it's understood that speaking one's mind could be a really bad career move.

Most people I talked to seemed wary of appearing to demean their relatives to a stranger and sensitive about giving a bad impression of Iceland. But once they got going, it was talk, talk, talk into the night, spewing every story and conspiracy theory imaginable—most of them fluent in English and otherwise speaking an ancient Viking tongue that sounded like a tape recorder playing backward. There were even glimpses of an abiding belief in elves and the "hidden people," who live in rocks that roads have been routed around so as not to disturb them. What kind of spiritual havoc might come from moving the Earth on the scale of Kárahnjúkar?

THE PROBLEM OF CHOICE

Late one night, in a hut on a lake deep in the eastern highlands, Ómar, the reporter, while empathizing by candlelight with the people of the regions, lamented the larger course of events. "If only instead of looking for ways to use the land for heavy industry, Iceland had kept the land intact and for 20 years had worked on how to sell her intact, we'd have gotten much more for her."

Why wasn't Iceland positioning itself as a world leader in the development of hydrogen alternatives? Or marketing what is arguably the world's oldest parliamentary democracy as a mecca for law students? Or more aggressively branding Icelandic products in the international market, which would surely pay for such remote purity? How about some high-end, eco-conscious tourism on a par with, say, the Galápagos Islands? Or capitalizing on the country's rich heritage?

At the Culture House, for instance, you can view original medieval manuscripts, like Egil's Saga, smudgy pages in careful script written on calfskin vellum. The Codex Regius of the Edda poems is also there, the oldest and most important collection of poems describing the gods, heroes, and mythology of antiquity, said to have inspired artists from Wagner to Tolkien.

"But we haven't sold this," said Andri Snær Magnason, author of *Dreamland: Self-Help for a Frightened Nation,* a surprise, runaway

Dwarfed by the jagged wall of the Kambhorn, derelict buildings mark where a family struggled to wrest a living raising sheep until its last members died out. Since 1900 the percentage of Icelanders [illegible] farming has fallen from 77 to 4

HERE THEY ALL WERE, ONE BIG UNHAPPY FAMILY. EVERYONE WAS TRYING TO SAVE ICELAND. "A MENTAL CIVIL WAR," SOMEBODY CALLED IT. A WAR OF DREAMS.

best-seller that exposed the spell he thought the Icelandic people had been under regarding the dam and smelter and galvanized the conservation movement. "We're selling people cuddly stuffed puffins but not promoting real depth."

Even more important, modern Icelandic society, Andri felt, had no template for how to conduct a national dialogue. As a result, the majority of people, instead of making conscious, informed decisions about issues like Kárahnjúkar, had—out of a combined sense of trust in the system, fear of the system, and intellectual laziness in the face of complicated and precarious issues—passively supported something they didn't really understand.

Here was Iceland (or at least Reykjavík), Andri said, "at a peak of economic growth and progress"—thanks to thriving pharmaceutical and tech industries, the privatization of the banks, and a general liberalization of the financial sector over the past 20 years. At such a juncture, he said, the problem should be "a problem of choice"—not of smelter or death. Not the old fear of privation but a sense that the future is limited only by Icelanders' belief in themselves and their willingness to reawaken that primeval Viking spirit idling restlessly behind their seeming impassivity: the daring and inventiveness, the sense of artistry, and of tremendous resolve, from the old ways and the old days of old Iceland, when it was believed, as one former egg farmer told me, "that you could change the world with a poem."

So here they all were, one big unhappy family. The environmentalists were trying to save Iceland. The industrialists were trying to save Iceland. Everyone was trying to save Iceland.

"A mental civil war," somebody called it.

A war of dreams.

WHAT PRICE FREEDOM?

Soon after the flooding, in what looked like a concession to the burgeoning green constituency, the government decided to designate a huge, long-awaited national park—a wilderness area in and around Vatnajökull glacier, adjacent to Kárahnjúkar, that may encompass some 5,000 square miles.

The park was a major victory, perhaps the first of many, it was hoped by conservation leaders such as Árni Finnsson, director of the Iceland Nature Conservation Association, a restless, sensitive man with a flop of strawberry blond hair and a voice low and raspy from his having lost one of his vocal cords in a car accident. He was ecstatic about the park and also the movement's enhanced political clout. A new, green party emerged, chaired by Ómar, called Iceland's Movement; and though it failed in last May's elections to garner the minimum 5 percent of the vote required by law to earn any seats in the parliament (it got 3.3 percent), and its future was unclear, the political landscape appeared to be changing. The greens were squarely in the game now, environmental issues were higher on the public agenda, and all of Iceland's parties were going to have to take them into account. Pro-Kárahnjúkar people were saying things like "we're nearing the end of the road on aluminum," and energy-intensive alternatives such as "server farms," huge computer-processing centers, were on the horizon, as was a shift to geothermal energy, which can be less invasive than hydro.

Meanwhile, on the aluminum side, as of last fall: Smelting had begun at the Alcoa plant in Reyðarfjörður, with full production expected this year—344,000 metric tons annually; the company was planning another smelter, using geothermal energy, in the northeast town of Húsavík; and Century Aluminum was expected to start building a second smelter this year, near the airport outside Reykjavík. (Though the townspeople of Hafnarfjörður narrowly voted down Alcan's bid to increase the size of its existing smelter there.)

So for now, Iceland is in a state that can only be described as schizophrenic.

"The question over the next few years," said Styrmir, the newspaper editor, "is can we compromise between those who are still inspired by

Aðalheiður Vilbergsdóttir's children can grow up amid the austere beauty of sea and stone because she took a job at the new smelter. They will inherit the balance their country strikes now—between harnessing its power and preserving its glory.

the idea of Iceland becoming rich by using our land for energy and the people who are fighting against any changes in the environment? Can we use geothermal energy in a better way than how it's been done in the past, with ugly above-ground zigzagging pipes that carry the steam and lie across the landscape like a broken zipper?"

A new, deep-drilling technology that could generate more power with fewer boreholes and exposed pipes is being explored by the national power industry (partly supported by Alcoa). The experiments involve drilling five kilometers down instead of the usual two, said Landsvirkjun's Siggi, to tap into "higher temperature and higher pressure and therefore up to ten times more power per borehole." But the results are years away. "Such a hot liquid is not easy to handle, so there are many technical hurdles." At the same time, the use of conventional geothermal technology, mostly to power aluminum plants in the southwest and northeast, is also being developed—and challenged by environmentalists. "Most of this is still in the exploration phase," said Siggi, about which Ómar remarked: "They call it research, but for that research they've got bulldozers in there and made roads and destroyed the area."

So the cold war slogs on, with geothermal energy emerging as the next environmental battleground.

For Iceland, and for any country groping for a balance between protecting its environment and growing its economy, the challenge is this: How do you change the infrastructure of a society—overcome the inertia and allow time for alternatives to develop—while people's lives and livelihoods are at stake? How do you develop eco-friendly industries that are also lucrative, thereby making conservation profitable as well as virtuous?

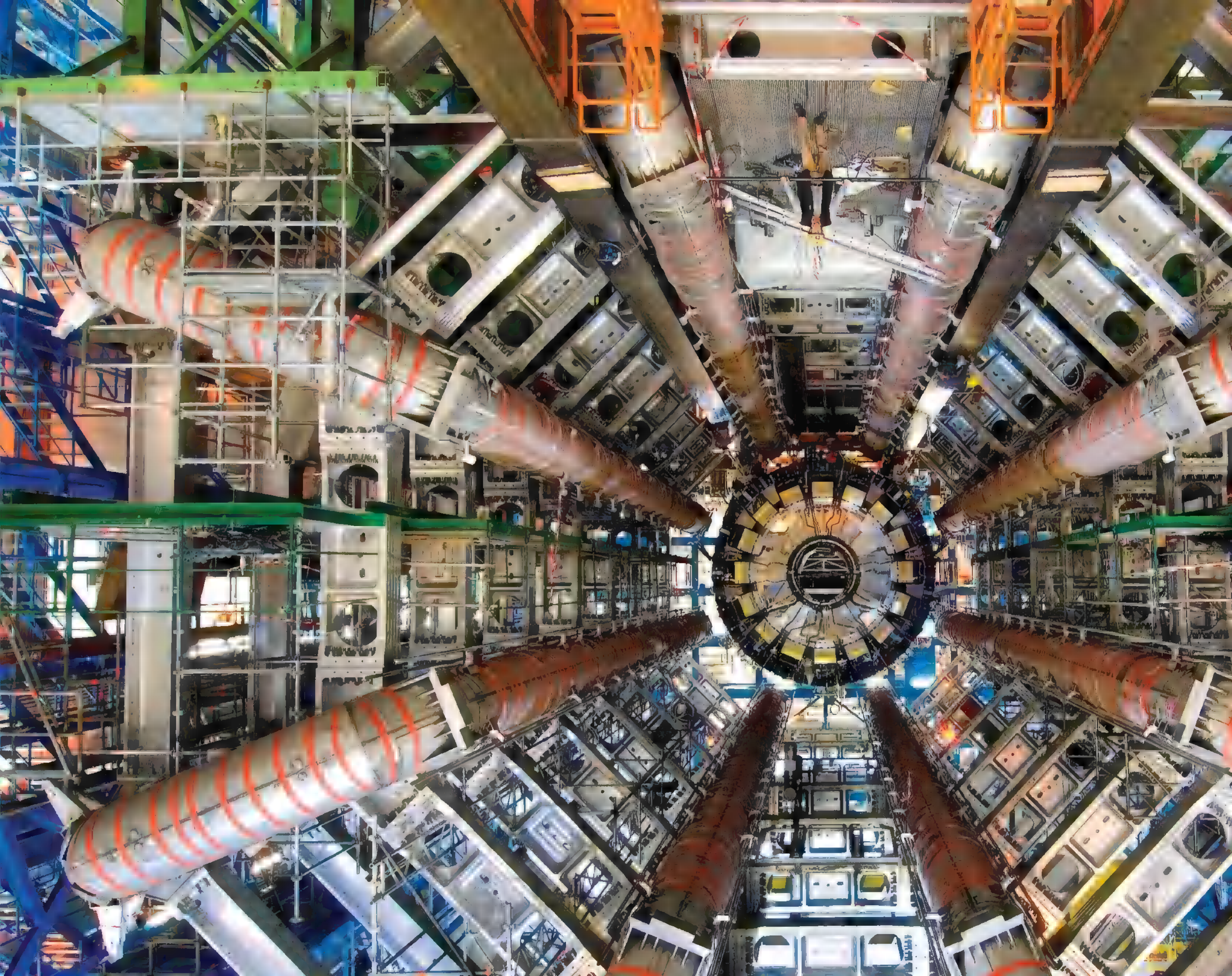
"I think Kárahnjúkar is the beginning of a new era," said a man filming a documentary about it. "An opportunity for transformation." □

Icelandic Split Jonas Bendiksen's images depict a country torn between industrializing and preserving its natural wonders, at **ngm.com.**

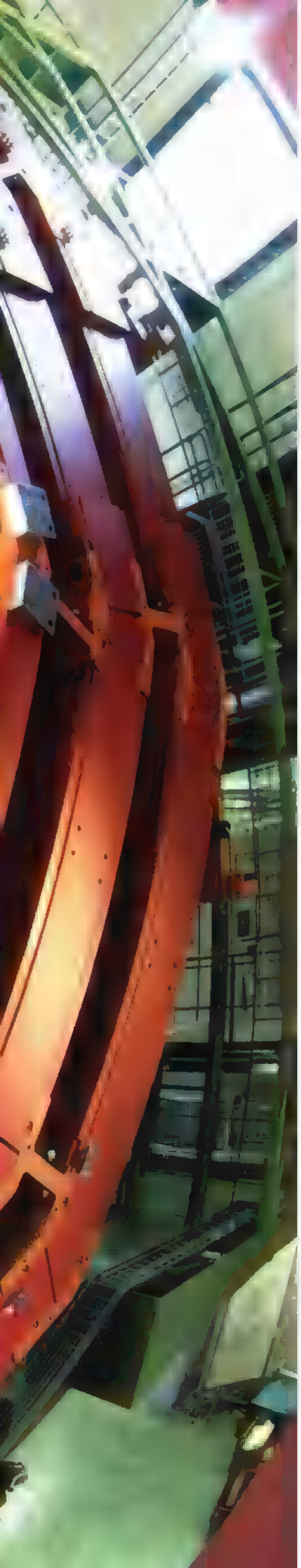
The massive ATLAS detector takes shape under the French-Swiss border. It will help physicists discover how the universe works by observing it on its smallest scale. MAXIMILIEN BRICE, CERN (RIGHT)

At the heart of all matter

The hunt for the God particle



The world's largest solenoid magnet will fit inside a steel cylinder at the heart of the Compact Muon Solenoid (CMS). CMS and three other main detectors housed in the Large Hadron Collider (LHC) may reveal unknown subatomic particles.



By Joel Achenbach
Photographs by Peter Ginter

If you were to dig a hole 300 feet straight down from the center of the charming French village of Crozet, you'd pop into a setting that calls to mind the subterranean lair of one of those James Bond villains. A garishly lit tunnel ten feet in diameter curves away into the distance, interrupted every few miles by lofty chambers crammed with heavy steel structures, cables, pipes, wires, magnets, tubes, shafts, catwalks, and enigmatic gizmos.

This technological netherworld is one very big scientific instrument, specifically, a particle accelerator—an atomic peashooter more powerful than any ever built. It's called the Large Hadron Collider, and its purpose is simple but ambitious: to crack the code of the physical world; to figure out what the universe is made of; in other words, to get to the very bottom of things.

Starting sometime in the coming months, two beams of particles will race in opposite directions around the tunnel, which forms an underground ring 17 miles in circumference. The particles will be guided by more than a thousand cylindrical, supercooled magnets, linked like sausages. At four locations the beams will converge, sending the particles crashing into each other at nearly the speed of light. If all goes right, matter will be transformed by the violent collisions into wads of energy, which will in turn condense back into various intriguing types of particles, some of them never seen before. That's the essence of experimental particle physics: You smash stuff together and see what other stuff comes out.

Those masses of equipment spaced along the tunnel will scrutinize the spray from the collisions. The largest, ATLAS, has

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Joel Achenbach is a Washington Post *staff writer. He has written columns and features for* National Geographic *since 1998. Peter Ginter is a German photographer known for his work in all fields of science.*

a detector that's seven stories tall. The heaviest, CMS (for Compact Muon Solenoid), is heftier than the Eiffel Tower. "Bigger is better if you're searching for smaller" could be the motto at the European Organization for Nuclear Research, better known by its historic acronym CERN, the international laboratory that houses the Large Hadron Collider.

It sounds scary, and it is. Building the LHC in a tunnel was a prudent move. The particle beam could drill a hole in just about anything, although the most likely victim would be the apparatus itself. One minor calamity has already happened: A magnet all but jumped out of its skin during a test in March 2007. Since then 24 magnets have been retrofitted to fix a design flaw. The people running the LHC aren't in a rush to talk about all the things that can go wrong, perhaps because the public has a way of worrying that mad scientists will accidentally create a black hole that devours the Earth.

The purpose of the LHC is simple but ambitious: to crack the code of the physical world; to figure out what the universe is made of.

The more plausible fear is that the collider will fail to find the things that physicists insist must be lurking in the deep substrate of reality. Such a big machine needs to produce big science, big answers, something that can generate a headline as well as interesting particles. But even an endeavor of this scale isn't going to answer all the important questions of matter and energy. Not a chance. This is because a century of particle physics has given us a fundamental truth: Reality doesn't reveal its secrets easily.

Put it this way: The universe is a tough nut to crack.

Go back a little more than a century to the late 1800s, and look at the field of physics: a mature science, and rather complacent. There were those who believed there wasn't much more to do than smooth out some rough edges in nature's plan. There was a sensible order to things, a clockwork universe governed by Newtonian forces, with atoms as the foundation of matter. Atoms were indivisible by definition—the word comes from the Greek for "uncuttable."

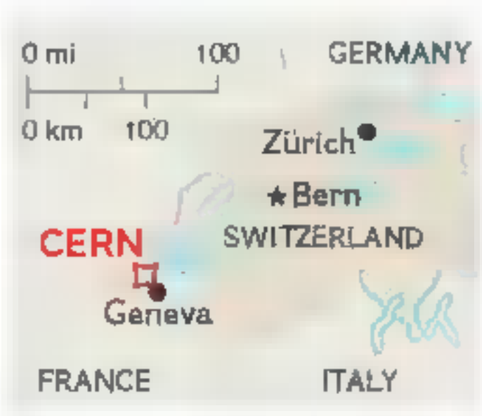
But then strange things started popping up in laboratories: x-rays, gamma rays, a mysterious phenomenon called radioactivity. Physicist J. J. Thomson discovered the electron. Atoms were not indivisible after all, but had constituents. Was it, as Thomson believed, a pudding, with electrons embedded like raisins? No. In 1911 physicist Ernest Rutherford announced that atoms are mostly empty space, their mass concentrated in a tiny nucleus orbited by electrons.

Physics underwent one revolution after another. Einstein's special theory of relativity (1905) begat the general theory of relativity (1915), and suddenly even such reliable concepts as absolute space and absolute time had been discarded in favor of a mind-boggling space-time fabric in which two events can never be said to be simultaneous. Matter bends space; space directs how matter moves. Light is both a particle and a wave. Energy and mass are interchangeable. Reality is probabilistic and not deterministic: Einstein didn't believe that God plays dice with the universe, but that became the scientific orthodoxy.

By the early 1930s Ernest Lawrence had invented the first circular particle accelerator, or "cyclotron." It fit in his hand.

Now the U.S. government has an accelerator that's hidden beneath several square miles of tallgrass prairie and a small herd of buffalo at its Fermilab facility west of Chicago. When you drive on the Junipero Serra freeway near Palo Alto, California, you pass directly over a two-mile linear accelerator. The LHC crosses the border between two countries. There are still physicists who do tabletop physics—who try to get big answers with modest means—but realistically you need huge, powerful, energetic devices to pry open the fabric of reality.

We know things today that Einstein, Rutherford, Max Planck, Niels Bohr, Werner Heisenberg, and the rest of the great physicists of a century ago couldn't have imagined. But we're nowhere near a final theory of physical reality. Molecules are made of atoms; atoms are made of

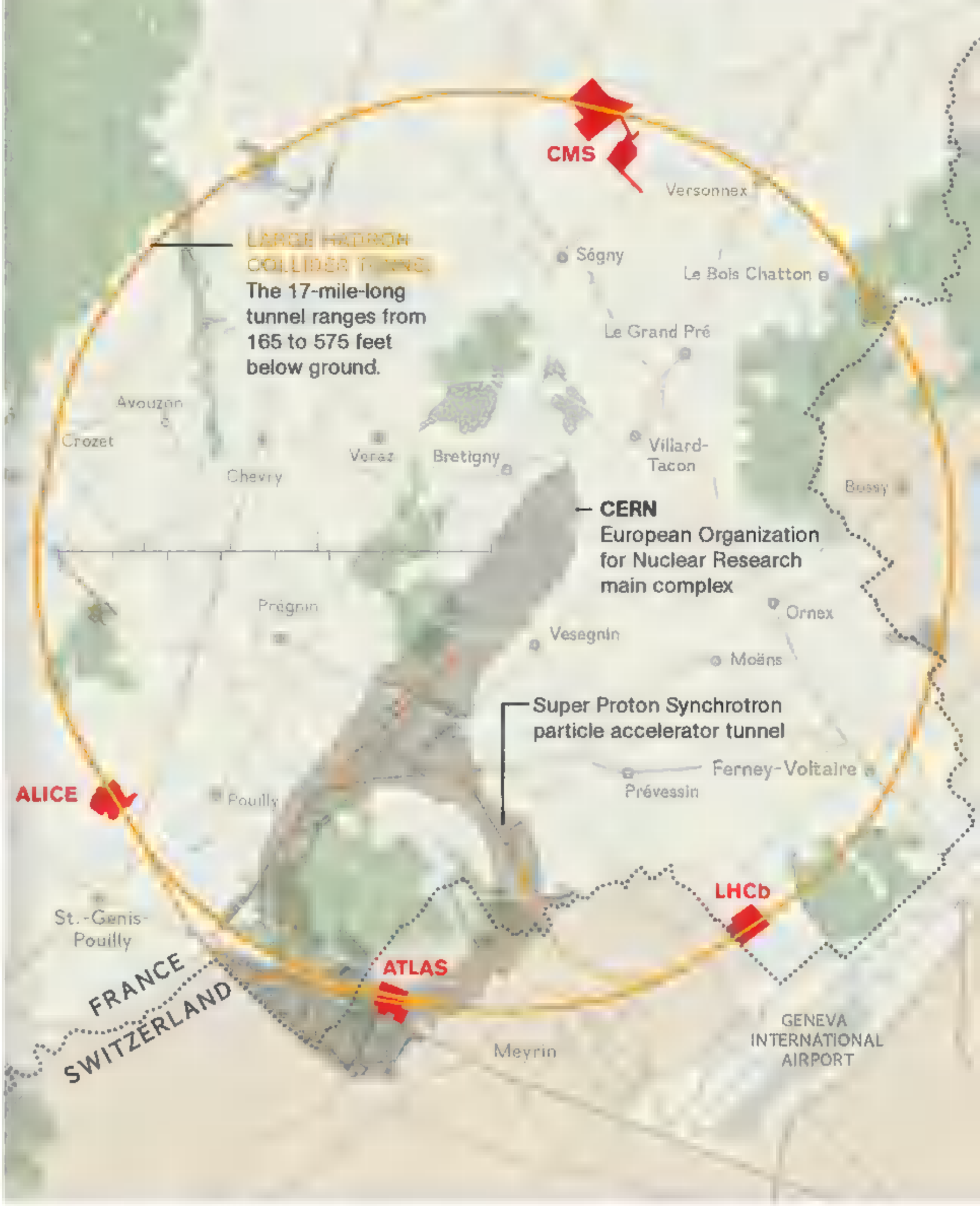


MAIN LHC DETECTORS

CMS & ATLAS
Designed to explore the fundamental forces of the universe and the basic nature of matter

ALICE
Will analyze the collisions of lead nuclei to study quark-gluon plasma, ■ state of matter that existed immediately after the big bang

LHCb
May help scientists understand why the big bang yielded a universe with more matter than antimatter



SOURCE: CERN
SEAN McNAUGHTON, NGM

The most ambitious particle physics experiment ever undertaken, the LHC whirls subatomic particles around a 17-mile-long tunnel underlying the border between Switzerland and France. An older accelerator, the Super Proton Synchrotron, feeds particles into the LHC. Thousands of scientists from almost 50 nations have collaborated on the project.

particles called protons, neutrons, and electrons; protons and neutrons (which are the "hadrons" that give the collider its name) are made of odd things called quarks and gluons—but already we're into a fuzzy zone. Are quarks fundamental particles, or made of something smaller yet? Electrons are believed to be fundamental, but you wouldn't want to bet your life on it.

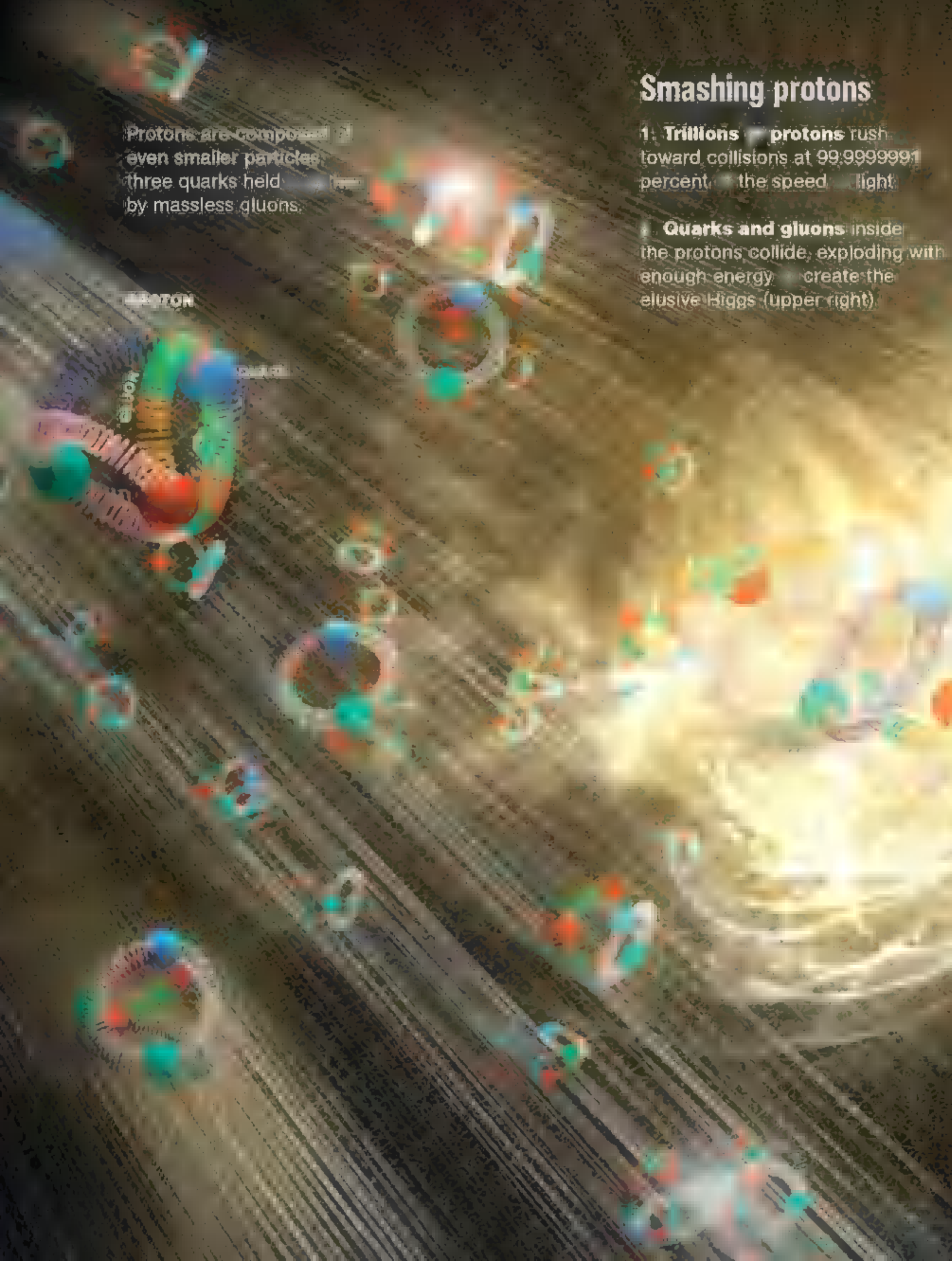
Still, theoretical physicists crave simplicity. They'd like to have a model of reality that snaps together neatly. Their standard model, developed in the 1960s and 1970s, is widely viewed as unwieldy, like a contraption with too many loose ends and knobs and dangling bits. It includes 57 fundamental particles, with no rhyme or reason to many of the numbers describing how the particles interact. "We had a theory that started out really beautiful and elegant," says Joe Lykken, a theorist at Fermilab, "and then someone beat on it and made it really ugly."

The standard model can't explain several towering mysteries about the universe that have their roots in the minuscule world of particles and forces. If there's one truly extraordinary concept

The big science of the very small

When atomic nuclei smash together with unprecedented energy in the Large Hadron Collider, physicists hope to create exotic particles and states of matter abundant only during the first instants of the universe. One particle they seek is the Higgs boson, the so-called God particle. It's the missing evidence in a theory that explains a basic characteristic of the universe: how fundamental particles acquire mass.

Why do physicists think the Higgs exists? Just as protons and electrons interact via the electromagnetic field that pervades all space, there may be a field—the Higgs field—that imbues fundamental particles with mass. Finding the Higgs particle will prove the field exists. LHC physicists expect the Higgs to erupt from the collision of protons traveling at nearly the speed of light (below).



Smashing protons

1. **Trillions of protons** rush toward collisions at 99.9999991 percent of the speed of light.

2. **Quarks and gluons** inside the protons collide, exploding with enough energy to create the elusive Higgs (upper right).

3. The Higgs particle, produced in 100 to 200 times the mass of a proton, is unstable: it will last less than a millionth of a billionth of a billionth of a second before decaying into a spray of other particles

4. Evidence for the Higgs will be found in the telltale spirals and streaks left in LHC detectors by the particles created as it disintegrates

Frontiers beyond the Higgs

Why is there anything?
Theoretically, the big bang should have yielded equal amounts of matter and antimatter that annihilated each other, leaving a largely empty universe. So why is our universe almost exclusively matter?

What fills the darkness?
The movements of distant galaxies and supernovae hint that the dark expanse of space holds vastly more matter and energy than we see in all the stars and galaxies. The LHC could shed light on this dark matter and dark energy.

SOURCES: CERN; DANIELE BENEDETTI, CERN; STEPHEN REUCROFT, NORTHEASTERN UNIVERSITY; MICHAEL S. TURNER, UNIVERSITY OF CHICAGO
ART BY MOONRUNNER DESIGN. TEXT AND DESIGN BY SEAN MCNAUGHTON, NGM ART

to emerge from the past century of inquiry, it's that the cosmos we see was once smaller than an atom. This is why particle physicists talk about cosmology and cosmologists talk about particle physics: Our existence, our entire universe, emerged from things that happened at the smallest imaginable scale. The big bang theory tells us that the known universe once had no dimensions at all—no up or down, no left or right, no passage of time, and laws of physics beyond our vision.

How does an infinitely dense universe become a vast and spacious one? And how is it filled with matter? In theory, as the early universe expanded, energy should have condensed into equal amounts of matter and antimatter, which would then have annihilated each other on contact, reverting to pure energy. On paper, the universe should be empty. But it's full of stars and planets and charming French villages and so on. The LHC experiments may help physicists understand our good fortune to be in a universe that grew with just enough more matter than antimatter.

What about the riddle of dark matter? Scrutiny of the motion of distant galaxies indicates that they are subject to more gravity than their visible matter could possibly account for. There must be some exotic hidden matter in the mix. A theory called supersymmetry could account for this: It states that every fundamental particle had a much more massive counterpart in the early universe. The electron might have had a hefty partner that physicists refer to as the selectron. The muon might have had the smuon. The quark might have had…the squark. Many of those supersymmetric partners would have been unstable, but one kind may have been just stable enough to survive since the dawn of time. And those particles might, at this very second, be streaming through your body without interacting with your meat and bones. They might be dark matter.

By smashing pieces of matter together, creating energies and temperatures not seen since the universe's earliest moments, the LHC could reveal the particles and forces that wrote the rules for everything that followed. It could help answer one of the most basic questions for any sentient being in our universe: What is this place?

There's one puzzle piece in particular that physicists hope to pick out of the debris from the LHC's high-energy collisions. Some call it the God particle.

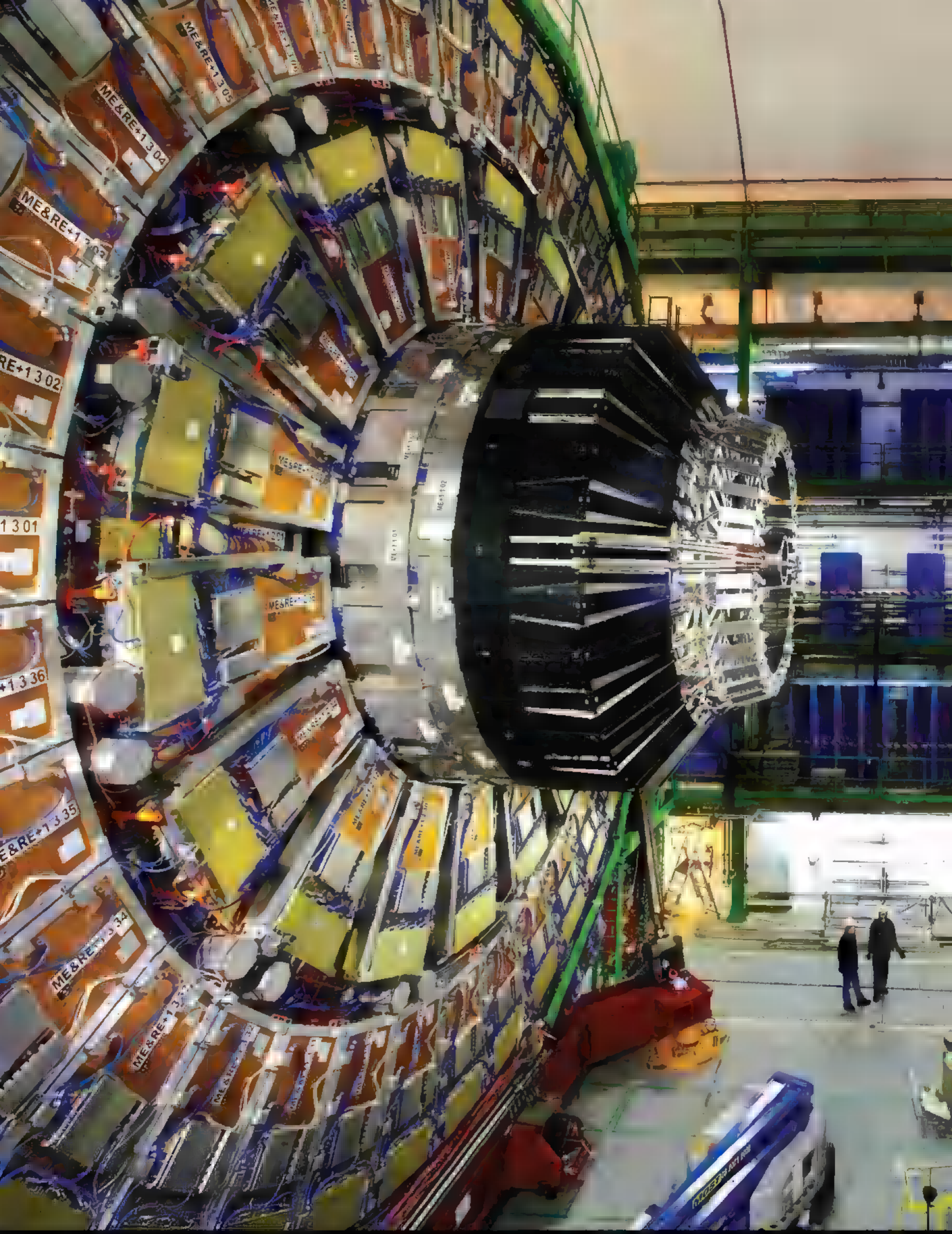
The first thing you learn when you ask scientists about the God particle is that it's bad form to call it that. The particle was named a few years back by Nobel Prize-winning physicist Leon Lederman, who has a knack for turning a phrase. Naturally the moniker took root among journalists, who know a good name for a particle when they hear one (it beats the heck out of the muon or the Z-boson).

When those magnets are turned on, says scientist Richard Jacobsson, a person swinging a hammer in the vicinity would do well to wear a helmet.

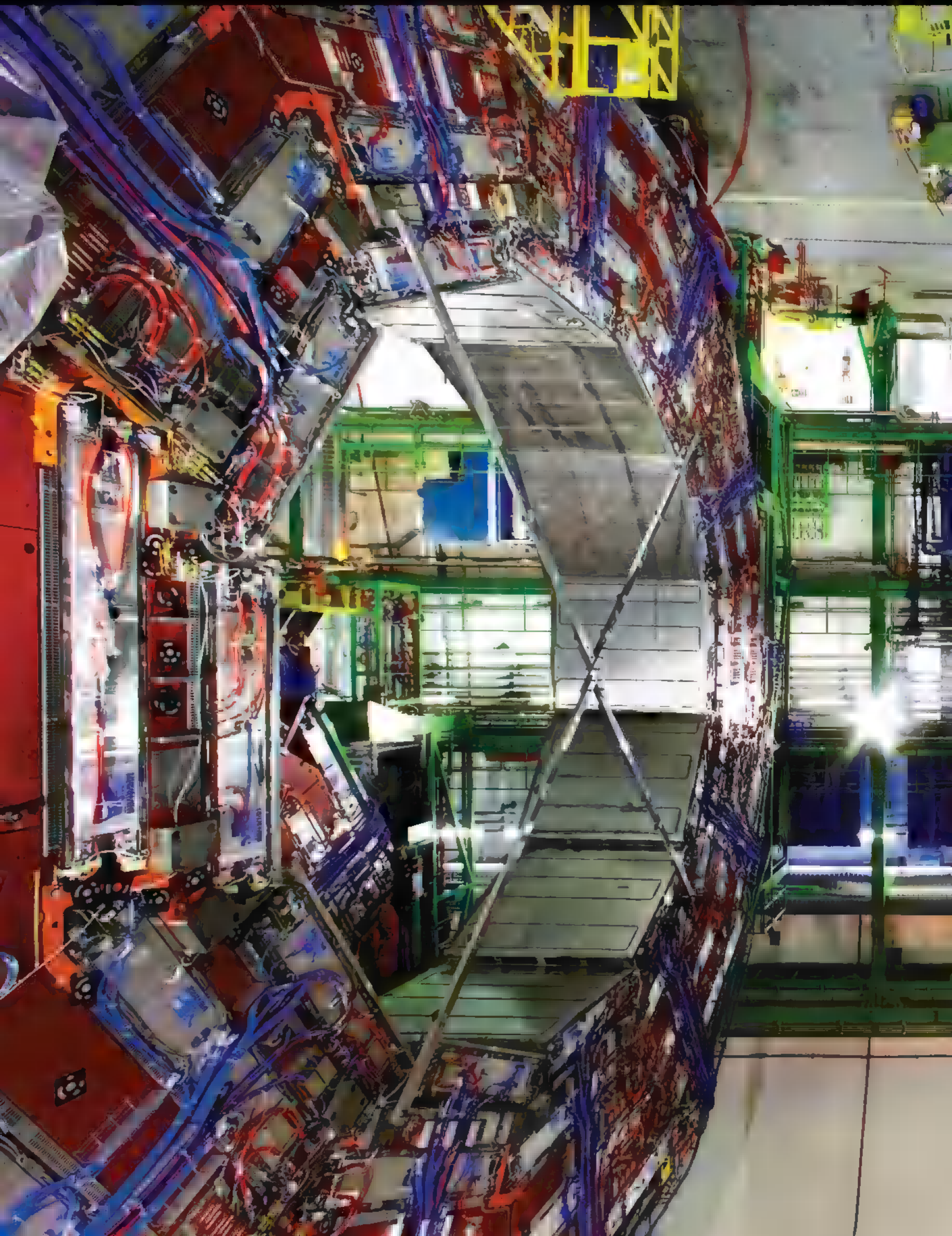
The preferred name for the God particle among physicists is the Higgs boson, or the Higgs particle, or simply the Higgs, in honor of the University of Edinburgh physicist Peter Higgs, who proposed its existence more than 40 years ago. Most physicists believe that there must be a Higgs field that pervades all space; the Higgs particle would be the carrier of the field and would interact with other particles, sort of the way a Jedi knight in *Star Wars* is the carrier of the "force." The Higgs is a crucial part of the standard model of particle physics—but no one's ever found it.

Theoretical physicist John Ellis is one of the CERN scientists searching for the Higgs. He works amid totemic stacks of scientific papers that seem to defy the normal laws of gravity. He has long, gray hair and a long, white beard

An engineer works on one of more than a thousand magnets that will steer particles toward collision. The collider's innards include pipes for the particle beams and liquid-helium-filled pipes that will cool the magnets to minus 456°F, so they can carry more electric current and exert greater force.



Glistening with sensors, components of the CMS detector near completion for a start-up later this year. As protons collide, detectors will track a flood of data that could yield evidence of elusive particles that physicists seek.



and, with all due respect, looks as if he belongs on a mountaintop in Tibet.

Ellis explains that the Higgs field, in theory, is what gives fundamental particles mass. He offers an analogy: Different fundamental particles, he says, are like a crowd of people running through mud. Some particles, like quarks, have big boots that get covered with lots of mud; others, like electrons, have little shoes that barely gather any mud at all. Photons don't wear shoes—they just glide over the top of the mud without picking any up. And the Higgs field is the mud.

The Higgs boson is presumed to be massive compared with most subatomic particles. It might have 100 to 200 times the mass of a proton. That's why you need a huge collider to produce a Higgs—the more energy in the collision, the more massive the particles in the debris. But a jumbo particle like the Higgs would also be, like all oversize particles, unstable. It's not the kind of particle that sticks around in a manner that we can detect—in a fraction of a fraction of a fraction of a second it will decay into other particles. What the LHC can do is create a tiny, compact wad of energy from which a Higgs might spark into existence long enough and vivaciously enough to be recognized. Building a contraption like the LHC to find the Higgs is a bit like embarking on a career as a stand-up comic with the hope that at some point in your career you'll happen to blurt out a joke that's not only side-splittingly funny but also a palindrome.

"We had a theory that started out beautiful and elegant," says Joe Lykken at Fermilab, "and then someone beat on it and made it really ugly."

You can take an elevator down into the LHC tunnel if you wear a hard hat and carry an emergency oxygen mask. When I visited, I found a major construction project still under way, with all the usual sounds of blowtorches and metal saws. Workers were installing magnets. They've since completed the process, having installed more than 1,600 magnets, most half the length of a basketball court and weighing more than 30 tons.

Oddly enough, none of those magnets will accelerate particles. The acceleration will come from electrical waves in a separate apparatus that boosts particles around the ring. The job of the magnets is to nudge the beams of particles to bend ever so slightly around the ring. Lots of particles moving at nearly the speed of light have only one desire in life: to keep moving straight ahead. So the bend needs to be gradual—thus the 17-mile circumference of the ring.

When the particles collide, they'll produce showers of debris as their energy gets transformed into mass. The physicists won't see the Higgs itself in that shower, but two of the four major experiments that the LHC will perform are capable of recording the detritus of the disintegrating Higgs—the telltale signal that a Higgs is decaying. And the assumption is that only the rare collision—one among many trillions—will produce a Higgs. Most collisions won't result in anything terribly interesting. The particle—or rather its debris—will show up in a detector's computers, found by sorting through massive amounts of data measured in petabytes—thousands of trillions of bits.

A major issue for CERN is how to decide that they've found the Higgs. How much proof do you need? They've got two experiments competing to find the same particle. Do they announce the discovery by one experiment even if the other hasn't confirmed it yet? The relationship between the ATLAS and CMS experiments is like Coke versus Pepsi. They're working the same side of the street, but with different techniques. And they're highly competitive. The day I went to see ATLAS, the man in charge, Peter Jenni, found out that I'd already seen the CMS experiment. "Now you'll see something bigger," he said. His voice carried a slight my-detector-is-better-than-yours tone.

CMS was built at the surface and will be lowered in several large chunks down through a shaft into a cavern along the tunnel. Tactlessly, I asked Dave Barney, one of the CMS scientists, what would happen if something went wrong and a part was dropped. You know, splat.

"That won't happen," he said fiercely. "That's the worst thing imaginable."

I realized that I was treading on delicate territory whenever I asked what kinds of things could go wrong with the LHC. No, the collider can't blow up the world, but this is high-energy physics. When those magnets are turned on, scientist Richard Jacobsson pointed out, a person swinging a hammer in the vicinity would do well to wear a helmet.

When the LHC starts smashing particles, Europe will suddenly become the dominant location for particle physics, and the United States will find itself struggling to figure out how to stay relevant. Perhaps that's a petty concern given the magnitude of what the LHC might turn up, but it's something people talk about. Since the Manhattan Project there's been a general notion that the U.S. dominates the world of physics. Until now, the energy frontier has been at Fermilab, home of the Tevatron. That collider has found some important particles, but it might not have quite enough juice to nail the Higgs.

Some U.S. money has gone into the LHC, which will cost billions of dollars: five, maybe ten—the exact number is elusive (the science will be precise, but the accounting apparently follows the Uncertainty Principle). But most of the engineering is being done by European firms. Jürgen Schukraft, who supervises an LHC experiment named ALICE (which will re-create conditions the same as those just after the big bang), said, "The brain drain that used to go from Europe to the States definitely has reversed."

The cynic might say that there's no practical use for any of this, that there might be other uses for all the money and brainpower going into these particle guns. But we live in a civilization shaped by physics. We know that the forces within an atom are so powerful that, unleashed and directed against humanity, they can obliterate cities in an instant. The laptop computer on which I'm writing uses microprocessors that would not exist had we not discovered quantum physics and the quirky behavior of electrons. This story will be posted on the World Wide Web—invented, in case you hadn't heard, at CERN, by computer scientist Tim Berners-Lee. Maybe you're reading it while listening to your iPod, which wouldn't exist but for something called "giant magnetoresistance." Two physicists discovered it independently in the late 1980s, with not much thought of how it might eventually be used. It became crucial to making tiny consumer electronics that used magnetized hard disks. The physicists won a Nobel Prize in 2007, and you got a nifty sound system that's smaller than a Hershey bar.

When I asked Peter Jenni why the LHC is important, he said, "Humankind differs from a collection of ants. We have intellectual curiosity; we need to understand the mechanisms of life and the universe."

And anyone who thinks these big machines are soulless contraptions should listen to Richard Jacobsson. The LHC is replacing a particle detector he worked with for a decade. He came to know every inch of that instrument. He understood its moods and idiosyncrasies. The day the engineers came to rip it out, Jacobsson was overcome with emotion. "I had tears in my eyes," he said. "When they cut the cables, I thought blood would flow out." Now entire lives are wrapped up in the new machine, which physicists have been dreaming about since the 1980s.

Many people at CERN are hoping they'll get more than just answers: They'd like to uncover some new mysteries. John Ellis confided that he wouldn't even mind if the LHC failed to find a Higgs. "Many of us theorists would find that failure much more interesting than if we just find another boring old particle that some theorists predicted 45 years ago."

New puzzles seem a sure bet. After all, the universe doesn't seem to be constructed for our investigative convenience. We're big, sloppy meat-creatures who haven't even taken a good census of the species of bacteria that live in our bodies. One day I asked George Smoot, a Nobel laureate physicist, if he thinks our most basic questions will ever be answered.

"It depends on how I'm feeling on any particular day," he said. "But every day I go to work I'm making a bet that the universe is simple, symmetric, and aesthetically pleasing—a universe that we humans, with our limited perspective, will someday understand." □

Getting to the Bottom of Things Meet the Large Hadron Collider face-to-face and learn how it works in an interactive feature at **ngm.com.**

BEYOND THE BLUE

HOW ANCIENT VOYAGERS SETTLED THE

BY JOE SMITH

PHOTOGRAPHS BY STEPHEN ALVAREZ

Its sails like fins against the dawn sky, the Hokule'a, *a modern Hawaiian voyaging canoe built on ancient designs, glides into port after a 3,800-mile voyage.*

ONE HORIZON

FAR-FLUNG ISLANDS OF THE PACIFIC

ON EASTER ISLAND, *also called Rapa Nui, mysterious statues stand sentinel as the Milky Way spins cold and bright above. The giant* moai *may represent ancestors who ruled here after Polynesians discovered the island some thousand years ago during a wave of exploration that has been compared in its boldness to modern space voyages.*

MUCH OF THE THRILL of venturing to the far side of the world rests on the romance of difference. So one feels a certain sympathy for Captain James Cook on the day in 1778 that he "discovered" Hawaii. Then on his third expedition to the Pacific, the British navigator had explored scores of islands across the breadth of the sea, from lush New Zealand to the lonely wastes of Easter Island. This latest voyage had taken him thousands of miles north from the Society Islands to an archipelago so remote that even the old Polynesians back on Tahiti knew nothing about it. Imagine Cook's surprise, then, when the natives of Hawaii came paddling out in their canoes and greeted him in a familiar tongue, one he had heard on virtually every mote of inhabited land he had visited. Marveling at the ubiquity of this Pacific language and culture, he later wondered in his journal: "How shall we account for this Nation spreading it self so far over this Vast ocean?"

That question, and others that flow from it, has tantalized inquiring minds for centuries: Who were these amazing seafarers? Where did they come from, starting more than 3,000 years ago? And how could a Neolithic people with simple canoes and no navigation gear manage to find, let alone colonize, hundreds of far-flung island specks scattered across an ocean that spans nearly a third of the globe?

Answers have been slow in coming. But now a startling archaeological find on the island of Éfaté, in the Pacific nation of Vanuatu, has revealed an ancient seafaring people, the distant ancestors of today's Polynesians, taking their first steps into the unknown. The discoveries there have also opened a window into the shadowy world of those early voyagers.

At the same time, other pieces of this human puzzle are turning up in unlikely places. Climate data gleaned from slow-growing corals around the Pacific and from sediments in alpine lakes in South America may help explain how, more than a thousand years later, a second wave of seafarers beat their way across the entire Pacific.

On a lonely sun-drenched knoll on Éfaté, about half an hour's drive east of Port-Vila, the old colonial capital of Vanuatu, Matthew Spriggs is sitting on an upturned bucket, gently brushing away crumbs of dirt from a richly decorated piece of pottery unearthed only a few minutes earlier. "I've never seen anything like this," he says, admiring the intricate design. "Nobody has. This is unique."

That description fits much of what is coming out of the ground here. "What we have is a first- or second-generation site containing the graves of some of the Pacific's first explorers," says Spriggs, professor of archaeology at the Australian National University and co-leader of an international team excavating the site. It came to light only by luck. A backhoe operator, digging up topsoil on the grounds of a derelict

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Author Roff Smith's books include Cold Beer and Crocodiles: A Bicycle Journey into Australia. *Photographer Stephen Alvarez's work has taken him from 20,000-foot peaks to the world's deepest cave.*

CARVINGS *believed to depict canoe sails scar volcanic stone at the Kona Village Resort on Hawaii, which may once have been the site of a navigators' school. Researchers have studied these and other carvings for clues about ancient Polynesian technology.*

coconut plantation, scraped open a grave—the first of dozens in a burial ground some 3,000 years old. It is the oldest cemetery ever found in the Pacific islands, and it harbors the bones of an ancient people archaeologists call the Lapita, a label that derives from a beach in New Caledonia where a landmark cache of their pottery was found in the 1950s.

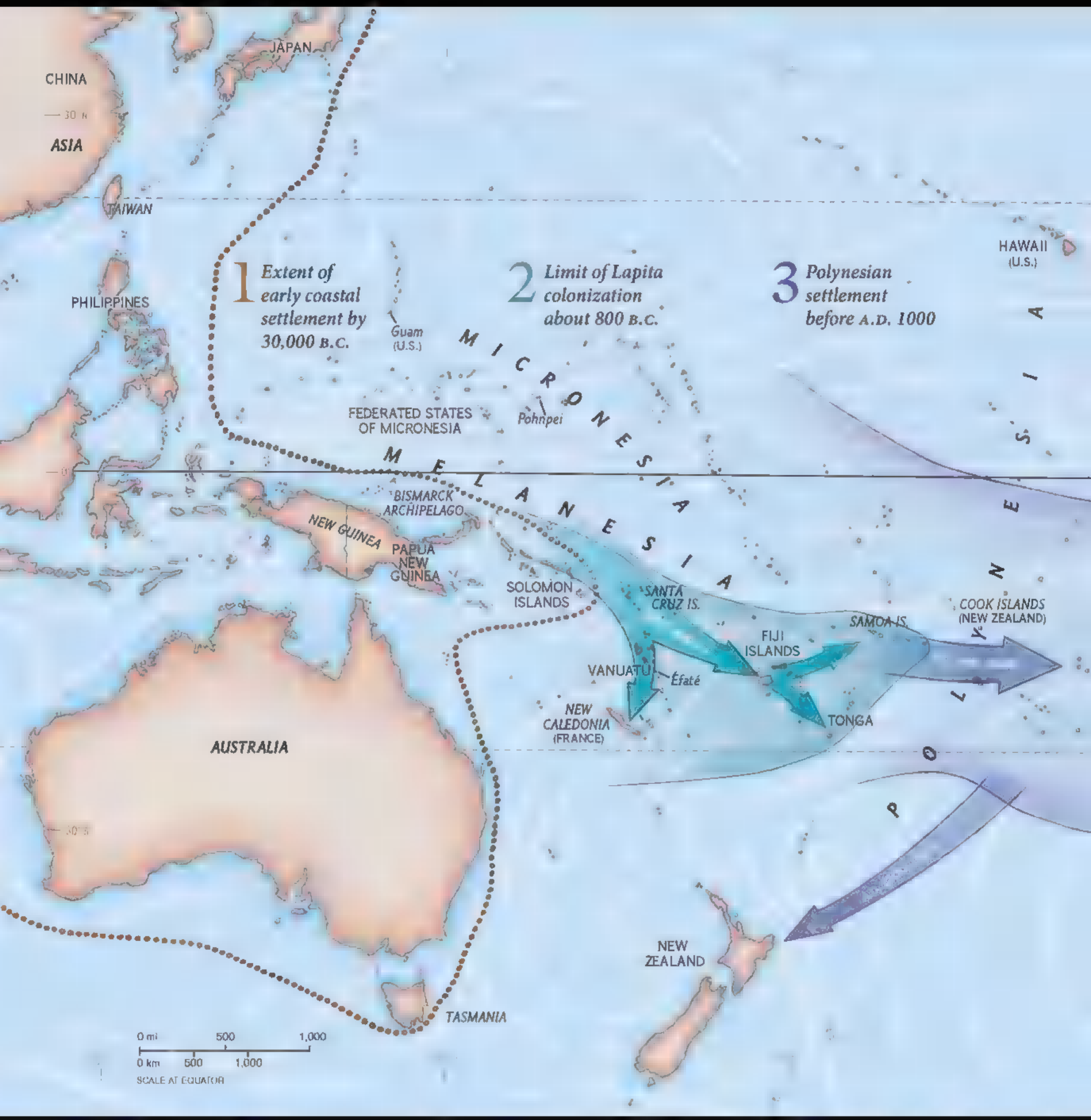
They were daring blue-water adventurers who roved the sea not just as explorers but also as pioneers, bringing along everything they would need to build new lives—their families and livestock, taro seedlings and stone tools. Within the span of a few centuries the Lapita stretched the boundaries of their world from the jungle-clad volcanoes of Papua New Guinea to the loneliest coral outliers of Tonga, at least 2,000 miles eastward in the Pacific. Along the way they explored millions of square miles of unknown sea, discovering and colonizing scores of tropical islands never before seen by human eyes: Vanuatu, New Caledonia, Fiji, Samoa.

It was their descendants, centuries later, who became the great Polynesian navigators we all tend to think of: the Tahitians and Hawaiians, the New Zealand Maori, and the curious people who erected those statues on Easter Island. But it was the Lapita who laid the foundation—who bequeathed to the islands the language, customs, and cultures that their more famous descendants carried around the Pacific.

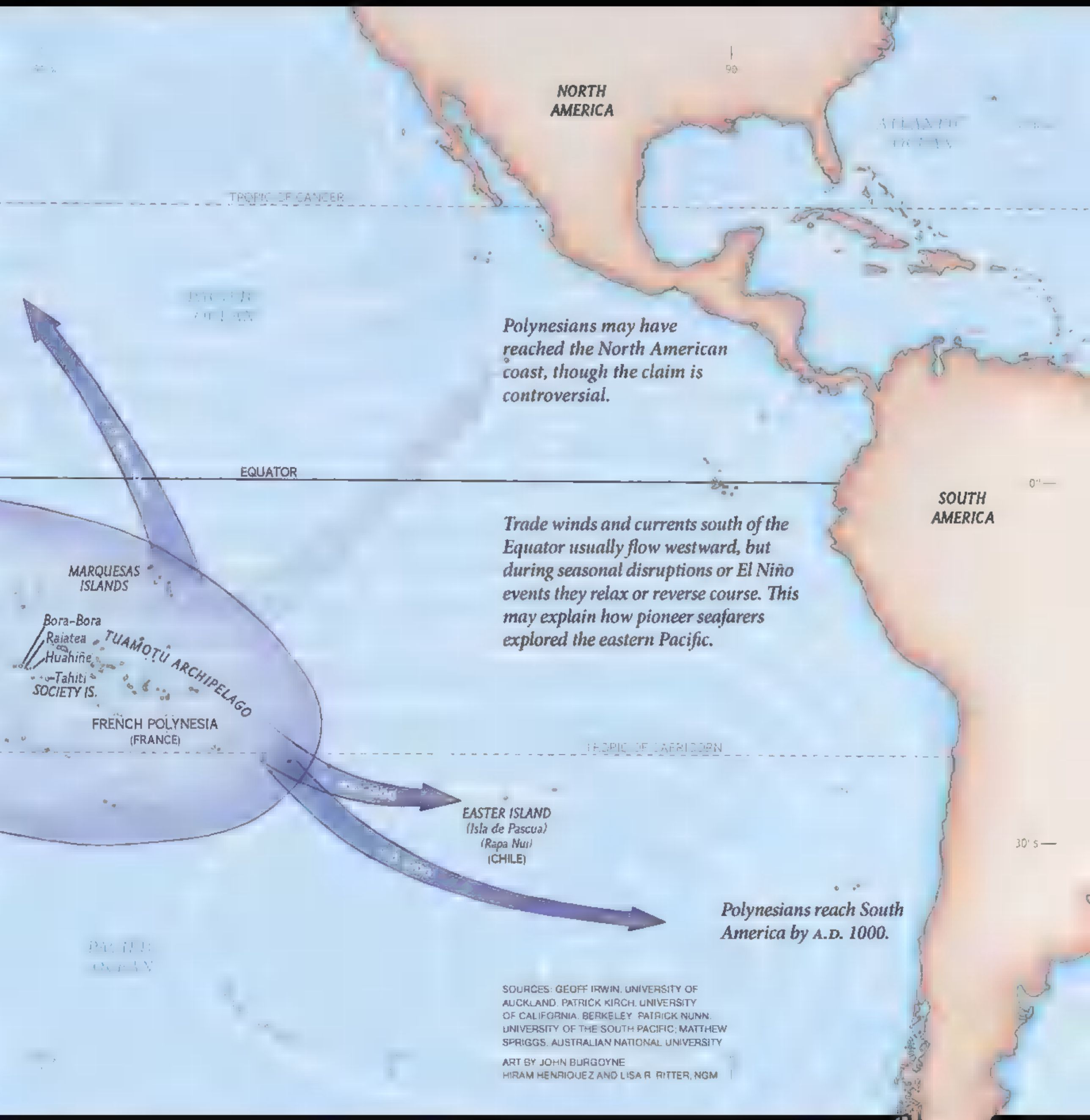
While the Lapita left a glorious legacy, they also left precious few clues about themselves. What little is known or surmised about them has been pieced together from fragments of pottery, animal bones, obsidian flakes, and such oblique sources as comparative linguistics and geochemistry. Although their voyages can be traced back to the northern islands of Papua New Guinea, their language—variants of which are still spoken across the Pacific—came from Taiwan. And their peculiar style of pottery decoration, created by pressing a carved stamp into the clay, probably had its roots in the northern Philippines.

With the discovery of the Lapita cemetery on Éfaté, the volume of data available to researchers has expanded dramatically. The bones of at least 62 individuals have been uncovered so far—including old men, young women, even babies—and more skeletons are known to be in the ground.

Archaeologists were also thrilled to discover six complete Lapita pots; before this, only four had ever been found. Other discoveries included a burial urn with modeled birds arranged on the rim as though peering down at the human bones sealed inside. It's an important



FANTASTIC VOYAGE



The Lapita people burst east across deep water from New Guinea some 3,000 years ago and within a few centuries reached Tonga and Samoa. After a pause of a thousand years, their Polynesian descendants pushed even farther, eventually settling the most remote islands.

find, Spriggs says, for it conclusively identifies the remains as Lapita. "It would be hard for anyone to argue that these aren't Lapita when you have human bones enshrined inside what is unmistakably a Lapita urn."

Several lines of evidence also undergird Spriggs's conclusion that this was a community of pioneers making their first voyages into the remote reaches of Oceania. For one thing, the radiocarbon dating of bones and charcoal places them early in the Lapita expansion. For another, the chemical makeup of the obsidian flakes littering the site indicates that the rock wasn't local; instead it was imported from a large island in Papua New Guinea's Bismarck Archipelago, the springboard for the Lapita's thrust into the Pacific. This beautiful volcanic glass was fashioned into cutting and scraping tools, exactly the type of survival gear explorers would have packed into their canoes.

A particularly intriguing clue comes from chemical tests on the teeth of several skeletons. Then as now, the food and water you consume as a child deposits oxygen, carbon, strontium, and other elements in your still-forming adult teeth. The isotope signatures of these elements vary subtly from place to place, so that if you grow up in, say, Buffalo, New York, then spend your adult life in California, tests on the isotopes in your teeth will always reveal your eastern roots.

Isotope analysis indicates that several of the Lapita buried on Éfaté didn't spend their childhoods here but came from somewhere else. And while isotopes can't pinpoint their precise island of origin, this much is clear: At some point in their lives, these people left the villages of their birth and made a voyage by seagoing canoe, never to return.

DNA teased from these ancient bones may also help answer one of the most puzzling questions in Pacific anthropology: Did all Pacific islanders spring from one source or many? Was there only one outward migration from a single point in Asia, or several from different points? "This represents the best opportunity we've had yet," says Spriggs, "to find out who the Lapita actually were, where they came from, and who their closest descendants are today."

There is one stubborn question for which archaeology has yet to provide any answers: How did the Lapita accomplish the ancient equivalent of a moon landing, many times over? No one has found one of their canoes or any rigging, which could reveal how the canoes were sailed. Nor do the oral histories and traditions of later Polynesians offer any insights, for they segue into myth long before they reach as far back in time as the Lapita.

"All we can say for certain is that the Lapita had canoes that were capable of ocean voyages, and they had the ability to sail them," says Geoff Irwin, a professor of archaeology at the University of Auckland and an avid yachtsman. Those sailing skills, he says, were developed and passed down over thousands of years by earlier mariners who worked their way through the archipelagoes of the western Pacific making short crossings to islands within sight of each other. The real adventure didn't begin, however, until their Lapita descendants neared the end of the Solomons chain, for this was the edge of the world. The nearest landfall, the Santa Cruz Islands, is almost 230 miles away, and for at least 150 of those miles the Lapita sailors would have been out of sight of land, with empty horizons on every side.

Yet that passage, around 1200 B.C., was just the warm-up act, for Santa Cruz and Vanuatu were the Lapita's first and easiest discoveries. Reaching Fiji, as they did a century or so later, meant crossing more than 500 miles of ocean, pressing on day after day into the great blue void of the Pacific. What gave them the courage to launch out on such a risky voyage?

The Lapita's thrust into the Pacific was eastward, against the prevailing trade winds, Irwin notes. Those nagging headwinds, he argues, may have been the key to their success. "They could sail out for days into the unknown and reconnoiter, secure in the knowledge that if they didn't find anything, they could turn

SECRETS OF THE LAPITA

Before 2004 few Lapita burial sites had been found. Then a backhoe operator on Éfaté island in Vanuatu accidentally discovered a cemetery containing at least 62 individuals. "We're seeing things we've never seen before," says archaeologist Stuart Bedford. The 3,000-year-old site is yielding details about these early explorers' distinctive ceramics, which bear stamped patterns (bottom), and their funeral rituals. No skulls were found with skeletons (right), some of which were also missing arm and rib bones. Evidence suggests the bones were removed after the bodies had decomposed. "The living knew who was buried there, and they were revisiting them," says Bedford. "It shows a very different attitude toward death."

THE OCEAN BOILS *as lava oozes into the waves at Hawai'i Volcanoes National Park. Scanning the horizon, Lapita and later Polynesian explorers may have used billowing columns of steam and ash from volcanic eruptions as navigation aids, steering for the promise of new land.*

POINT OF DEPARTURE, *the island of Raiatea in French Polynesia was a staging area for ancient voyagers who discovered Hawaii and New Zealand. After provisioning their canoes, sailors embarked from the temple of Taputapu-tea, the spiritual center of their world.*

about and catch a swift ride home on the trade winds. It's what made the whole thing work."

Once out there, skilled seafarers would detect abundant leads to follow to land: seabirds and turtles, coconuts and twigs carried out to sea by the tides, and the afternoon pileup of clouds on the horizon that often betokens an island in the distance.

Some islands may have broadcast their presence with far less subtlety than a cloud bank. Some of the most violent eruptions anywhere on the planet during the past 10,000 years occurred in Melanesia, which sits nervously in one of the most explosive volcanic regions on Earth. Even less spectacular eruptions would have sent plumes of smoke billowing into the stratosphere and rained ash for hundreds of miles. It's possible that the Lapita saw these signs of distant islands and later sailed off in their direction, knowing they would find land.

For returning explorers, successful or not, the geography of their own archipelagoes provided a safety net to keep them from overshooting their home ports and sailing off into eternity. Vanuatu, for example, stretches more than 500 miles in a northwest-southeast trend, its scores of intervisible islands forming a backstop for mariners riding the trade winds home.

All this presupposes one essential detail, says Atholl Anderson, professor of prehistory at the Australian National University and, like Irwin, a keen yachtsman: that the Lapita had mastered the advanced art of tacking into the wind. "And there's no proof that they could do any such thing," Anderson says. "There has been this assumption that they must have done so, and people have built canoes to re-create those early voyages based on that assumption. But nobody has any idea what their canoes looked like or how they were rigged."

However they did it, the Lapita spread themselves a third of the way across the Pacific, then called it quits for reasons known only to them.

Ahead lay the vast emptiness of the central Pacific, and perhaps they were too thinly stretched to venture farther. They probably never numbered more than a few thousand in total, and in their rapid migration eastward they encountered hundreds of islands—more than 300 in Fiji alone. Supplied with such an embarrassment of riches, they could settle down and enjoy what for a time were Earth's last Edens.

"It would have been absolutely amazing to have seen this place back then," says Stuart Bedford, an archaeologist from the Australian National University and co-leader, along with Matthew Spriggs, of the excavation on Éfaté. "These islands were far richer in biodiversity in those days than they are today." By way of illustration, he picks up a trochus shell the size of a dinner plate that was exposed in a test trench only that morning. "The reefs then were covered with thousands of these, each one a meal in itself. The seas were teeming with fish, and huge flightless birds could be found in the rain forest, virtually tame since they had never seen a human being. The Lapita would have thought they'd stumbled onto paradise."

As indeed it was. But theirs is a story of paradise found and lost, for although the Lapita were a Neolithic people, they had a modern capacity for overexploiting natural resources. Within a short span of time—a couple of generations, no more—those huge trochus shells vanished from the archaeological record. The plump flightless birds followed suit, as did a species of terrestrial crocodile. In all, it's estimated that more than a thousand species became extinct across the breadth of the Pacific islands after humans appeared on the scene.

Still, more than a millennium would pass before the Lapita's descendants, a people we now call the Polynesians, struck out in search of new territory. The pioneers who launched this second age of discovery some 1,200 or more years ago faced even greater challenges than their Lapita ancestors, for now they were sailing out beyond the island-stippled waters of Melanesia

STILTS AND STONE

From the simple stilt houses of the early Lapita to the giant moai of Easter Island, Pacific islanders developed a range of architectural and artistic styles. One of the most mysterious and massive examples is Nan Madol, seat of an ancient dynasty on the island of Pohnpei in Micronesia. Beginning about A.D. 500 and continuing for perhaps a thousand years, Pohnpeians built nearly a hundred artificial islets atop a flat expanse of reef. On these foundations they erected houses, ceremonial buildings, and robust tombs from thick columns of basalt (below). With its islets interspersed by canals, Nan Madol has been called the Venice of the Pacific.

IMPOSING WALLS *of a tomb complex on Pohnpei were built for Nan Madol's rulers around* A.D. *1350. Workers did not carve the stone but chose natural basalt columns—some weighing more than ten tons—and fit them expertly together.*

A LATE STOP *in the Polynesians' epic journey across Earth's greatest ocean, Easter Island wasn't necessarily their final destination. Evidence suggests that later explorers reached South America a few centuries before the arrival of another set of immigrants: Europeans.*

and western Polynesia and into the central Pacific, where distances are reckoned in thousands of miles, and tiny motes of islands are few and far between.

How difficult would it have been to find terra firma in all that watery wilderness? Consider this: When Magellan's fleet traversed the Pacific in 1520-21, sailing blind across an unknown sea, they went nearly four months without setting foot on land. (They missed the Society Islands, the Tuamotus, and the Marquesas, among other archipelagoes.) Many of the hapless sailors died of thirst, malnutrition, scurvy, and other diseases before the fleet reached the Philippines.

The early Polynesians found nearly everything there was to find, although it took them centuries to do so. Their feats of exploration are remembered and celebrated today at cultural festivals across the Pacific.

It is midafternoon, and a carnival atmosphere has settled over the beach at Matira Point on the island of Bora-Bora in French Polynesia. The air is fragrant with barbecue, and thousands of cheering spectators throng the shore to witness the grand finale of the Hawaiki Nui Va'a, a grueling, three-stage, 80-mile outrigger canoe race that virtually stops the nation.

"This is our heritage," says Manutea Owen, a former champion and a revered hero on his home island of Huahine. "Our people came from over the sea by canoe. Sometimes when I'm out there competing, I try to imagine what they must have endured and the adventures they had crossing those huge distances."

Imagination is now the only way one can conjure up those epic sea voyages. Like their Lapita ancestors, the earliest Polynesians left scanty artifacts of their seafaring life. Only a few pieces of one ancient canoe have ever been found, on Huahine in 1977. No surviving example of the great seagoing, sailing canoes thought

to have borne the Polynesian pioneers has yet been discovered.

European explorers left the earliest descriptions of watercraft used by Pacific islanders. In the less isolated waters of Micronesia, they encountered sleek, lateen-rigged canoes, a style that may have filtered into the Pacific from China and the Arab world. But in the remote corners of Polynesia—Hawaii, the Marquesas, and New Zealand—the explorers saw only simple craft. Atholl Anderson suspects that these were the truly indigenous boats, the kind that, centuries earlier, carried Polynesian settlers to far islands.

Anderson also questions conventional wisdom about Polynesian seamanship, citing a later explorer, Captain Cook. While Cook was impressed with the speed of the Polynesian canoes—they could literally sail circles around his ships—he came to question the islanders' ability to make long, intentional sea voyages. He records an account of a group of Tahitians who, helpless in the face of a contrary wind and unable to set a course for home, drifted hundreds of miles off course and were marooned on Aitutaki, in what is now the Cook Islands.

Rather than give all the credit to human skill and daring, Anderson invokes the winds of chance. El Niño, the same climate disruption that affects the Pacific today, may have helped scatter the first settlers to the ends of the ocean, Anderson suggests. Climate data obtained from slow-growing corals around the Pacific and from lake-bed sediments in the Andes of South America point to a series of unusually frequent El Niños around the time of the Lapita expansion, and again between 1,600 and 1,200 years ago, when the second wave of pioneer navigators made their voyages farther east, to the remotest corners of the Pacific. By reversing the regular east-to-west flow of the trade winds for weeks at a time, these "super El Niños" might have sped the Pacific's ancient mariners on long, unplanned voyages far over the horizon.

The volley of El Niños that coincided with the second wave of voyages could have been key to launching Polynesians across the wide expanse of open water between Tonga, where the Lapita stopped, and the distant archipelagoes of eastern Polynesia. "Once they crossed that gap, they could island hop throughout the region, and from the Marquesas it's mostly downwind to Hawaii," Anderson says. It took another 400 years for mariners to reach Easter Island, which lies in the opposite direction—normally upwind. "Once again this was during a period of frequent El Niño activity."

Exactly how big a role El Niño played in dispersing humans across the Pacific is a matter of lively academic debate. Could lucky breaks and fickle winds really account for so wide a spread of people throughout the 65-million-square-mile vastness of the Pacific? By the time Europeans came on the scene, virtually every speck of habitable land, hundreds of islands and atolls in all, had already been discovered by native seafarers—who ultimately made it all the way to South America. Archaeologists in Chile recently found ancient chicken bones containing DNA that matches early Polynesian fowl.

Nor did they arrive as lone castaways who soon died out. They came to stay, in groups, with animals and crops from their former homes. "My sense is that there had to be something more at work here than canoes simply blown before a wind," says Irwin. He notes that the trade winds slacken during the summer monsoon, which might have allowed islanders to purposefully sail eastward. Moreover, says Irwin, "Sophisticated traditions of seafaring were planted in every island. Did they develop independently in all of those islands? If so, why do these traditions bear so many details in common?

"But whatever you believe, the really fascinating part of this story isn't the methods they used, but their motives. The Lapita, for example, didn't need to pick up and go; there was nothing forcing them, no overcrowded homeland.

"They went," he says, "because they wanted to go and see what was over the horizon." □

The Quest Continues Geographer Jared Diamond, geneticist Spencer Wells, and other experts share insights from their Pacific research at **ngm.com.**

Bhutan's Enlightened Experiment

Guided by a novel idea, the tiny Buddhist kingdom tries to join the modern world without losing its soul.

Morning studies done, monks at Kurjey Lhakhang monastery head out for lunch—and into a new world. This year, after holding national elections, Bhutan will become a constitutional monarchy, ending a century of absolute rule by kings.

Boys fill sacks of potatoes—setting some aside for an elderly woman—near the village of Zhangkhar in eastern Bhutan. Roughly three-quarters of the country's 635,000 people survive by raising crops and livestock, but less than a tenth of this rugged land ■ arable.

By Brook Larmer
Photographs by Lynsey Addario

First come the high clear notes of the ceremonial trumpet. Then the Buddhist pilgrims, gravitating toward the sound. The sun has slid behind the mountains looming over Thimphu, capital of the Himalayan kingdom of Bhutan, and the day's final ritual is set to begin. Along the edge of the crowd, in pageboy haircuts and tattered robes, stand peasants who have traveled three days from their remote villages on their first visit to the big city, likely the only capital in the world without a traffic light. Near the center of the plaza clusters a group of Buddhist monks, arms linked, their betel-nut-stained teeth matching their burgundy robes. Together the monks and peasants and townspeople press forward to catch a glimpse of the main attraction: a small boy standing in the center of the circle, his bright orange shirt hanging down to his knees.

As the beat accelerates, the boy—seven-year-old Kinzang Norbu—hurls himself to the ground, spinning on his back so fast that he dissolves into a saffron blur. The crowd, steeped in the ancient mysticism of Bhutan, land of the flying tigress and the divine madman, might wonder if Norbu is the whirling reincarnation of a Buddhist saint. But the boy is channeling another, more mystifying world. Blasting from the speakers is not a Buddhist

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Brook Larmer wrote about Manchuria in September 2006. Lynsey Addario has won numerous awards for her documentation of areas of conflict and upheaval.

At ■ bar in Thimphu owned by their mother, 12-year-old Jigme Lhendup and his sister Sonam, 9, show off their hip-hop moves. A part-time movie actor, Jigme says his favorite subject in school is social studies: "I'm learning about the world."

incantation but the opening riffs of Shakira's risqué pop anthem, "Hips Don't Lie," piped in from a sleek white Macintosh laptop. And when Norbu twirls to a stop in a no-hands headstand, his shirt rides up to reveal his homage to global youth culture: red Nike high-top sneakers, baggy Adidas sweatpants, and a temporary tattoo that spells out, in jagged English letters, the name he and his homeys have adopted—"B-Boyz."

When the song fades out, Norbu struts away with an impish smile and a crooked-finger gang salute. His fellow B-Boyz whistle and cheer. The monks break into befuddled red-tooth grins. And the sun-burnished peasants? They just gape at the boy. If he were a masked festival dancer, spinning toward enlightenment, they might understand. And yet, for all the mutual incomprehension, the moment still binds them together. For in one mind-bending performance, Norbu has captured the essence of a country that is attempting the impossible: to leap from the Middle Ages to the 21st century without losing its balance.

King Wangchuck has tried to dictate the terms of Bhutan's opening. The felicitous phrase he invented to describe his approach: Gross National Happiness.

FOR MORE THAN A THOUSAND YEARS, this tiny realm—known by locals as Druk Yul, "land of the thunder dragon"—has survived in splendid isolation, a place the size of Switzerland wedged into the mountainous folds between two giants, India and China. Closed off from the outside world both by geography and deliberate policy, the country had no roads, no electricity, no motor vehicles, no telephones, no postal service until the 1960s. Even these days, its mesmerizing landscape evokes a place that time forgot: ancient temples perched high on mist-shrouded cliffs; sacred, unconquered peaks rising above pristine rivers and forests; a timbered chalet inhabited by a benevolent monarch and one of his four wives, all sisters. No wonder visitors can't resist calling Bhutan the last Shangri-la.

But even Shangri-la must change. When King Jigme Singye Wangchuck ascended the throne in 1972, Bhutan suffered from some of the highest poverty, illiteracy, and infant-mortality rates in the world—a legacy of the policy of isolation. "We paid a heavy price," the king would say later. His father, Bhutan's third king, had begun opening up the country in the 1960s, building roads, establishing schools and health clinics, pushing for United Nations membership. King Jigme Singye Wangchuck would go much further. With the self-confidence of a ruler whose country has never been conquered, he has tried to dictate the terms of Bhutan's opening—and in the process redefine the very meaning of development. The felicitous phrase he invented to describe his approach: Gross National Happiness.

For many Bhutanese, this idea is not merely a marketing tool or a utopian philosophy. It is their blueprint for survival. Guided by the "four pillars of Gross National Happiness"—sustainable development, environmental protection, cultural preservation, and good governance—Bhutan has pulled itself out of abject poverty without exploiting its natural resources (other than hydropower, sold to India as Bhutan's main source of foreign funds). Nearly three-quarters of the country is still forested, with more than 25 percent designated as national parks and other protected areas—among the highest percentages in the world. Rates of illiteracy and infant mortality have fallen dramatically, and the economy is booming. Tourism is growing too, though strict limits on new construction and a daily tax of up to $240 a visitor keep out the kind of

The Himalaya have long buffered Bhutan from political winds that rattled its neighbors but have also hampered its economic progress. Feudalism persisted until the 1950s, when the king abolished serfdom, redistributed land, and created the National Assembly.

backpacking hordes that have trampled Nepal.

On the eve of the millennium, in 1999, Bhutan granted its citizens access to television—the last country on the planet to do so. (The Internet trickled in the same year.) Euphoria reigned in the towns as the outside world in all its garish glory beamed into shops and living rooms. Pulling the lid off Pandora's box, however, raised concerns. What happens, after all, when an isolated, deeply conservative society is suddenly exposed to gangsta rapper 50 Cent and the World Wrestling Federation? Such questions carry extra weight in a vulnerable nation of 635,000 people, half of whom are under 22 years old.

Now comes the daring culmination of Bhutan's experiment: the move to democracy. Never before, say Bhutanese officials, has a beloved monarch voluntarily abdicated his throne to give power to the people. But in 2006 King Jigme Singye Wangchuck did just that, setting up an unusual convergence of events in 2008: a coronation (the fourth king ceremoniously hands over the raven crown to his 28-year-old son, Jigme Khesar Namgyel Wangchuck, who will serve as a constitutional monarch); a centennial celebration (the monarchy's hundredth birthday was in 2007, but a royal astrologer deemed this year more auspicious); and, most important, the formation by this summer of the country's first democratic government.

The real test of Gross National Happiness, then, is just beginning. Bhutan's new civilian leaders will face a raft of challenges, not least of which is a public that remains enamored of its kings and skeptical of democracy. The outside world peers in, wondering if this once forgotten Himalayan nation might help answer some of humankind's most vexing questions: How can a society maintain its identity in the face of the flattening forces of globalization? How can it embrace the good of the modern world without falling prey to

the bad? And can there ever be a happy balance between tradition and development?

A SHAFT OF MORNING LIGHT slants across the ancient temple floor, illuminating an elderly woman kneeling before a pillar of stone and 108 kernels of corn. The pillar is the most sacred relic in Nabji, a village tucked deep into the Black Mountains of central Bhutan, beyond the reach of roads and electricity. Legend holds that a small depression in the stone is the handprint of the Guru Rimpoche, the eighth-century mystic who arrived in Bhutan on the back of a flying tigress to spread a Tibetan form of Tantric Buddhism. And the kernels of corn? They are the calculus of devotion. Each time the gray-haired woman named Tum Tum prostrates herself, she slides one of the 108 kernels (a sacred number) across the floor. In three months she has moved the kernels 95,000 times—1,000 prostrations a day—and will continue until she reaches 100,000. "Sometimes I get so tired I fall over," says Tum Tum, whose knees have left grooves in the floorboards. "But I won't stop. This is our tradition."

> A sense of humor, even mischief, runs through Bhutanese Buddhism, whose earthy exuberance differs sharply from the ethereal calm of mainstream Theravada Buddhism.

Few places on the planet can be more rooted in tradition than rural Bhutan. Nearly 70 percent of the population lives in villages like Nabji, cradled by virgin forest and vertiginous mountains, six hours on foot from the nearest road. Nabji's terraced fields are empty today. It is a holy day on the lunar calendar, and the rough-hewn villagers circumambulate the temple in their finest robes—bright floor-length *kiras* for women, patterned knee-length *ghos* for men. The only signs of modernity are two solar panels installed on the temple roof to power a wireless telephone—and they don't work. Nabji's farmers put their faith in another kind of wireless communication: the prayer flags fluttering in the cypress trees above. "Every time the wind blows," says Rike, a former village headman, "it takes our prayers straight to the heavens. No machines required."

A sense of humor, even mischief, runs through Bhutanese Buddhism, whose earthy exuberance differs sharply from the ethereal calm of the better known Theravada Buddhism. The profusion of deities and demons can leave other Buddhists dazed. Sexual imagery also abounds, reflecting the tantric belief that carnal relations can be the gateway to enlightenment. Nobody embodied this idea more provocatively than the 16th-century lama Drukpa Kunley, better known as the Divine Madman, who remains a beloved saint in much of Bhutan. Carousing across the countryside, Kunley slew demons and granted enlightenment to young maidens with the magical powers of his "flaming thunderbolt." To this day, many Bhutanese houses are adorned with his sign of protection: an enormous painted phallus, often wrapped in a jaunty bow.

But flaming thunderbolts have not warded off change. Nabji's primary school, established almost a decade ago, is part of an educational revolution that has lifted Bhutan's literacy rate from 10 percent in 1982 to 60 percent today. The clinic next door is part of a push that has raised life expectancy nationwide from 43 years in 1982 to 66 today and, during the same span, reduced infant mortality from 163 deaths per thousand to 40. Nabji has no full-time doctors. Yet the day after the temple ceremony, three physicians from the district hospital in Trongsa hiked across the mountains to immunize the village children.

Nabji's isolation diminishes by the day: The booms reverberating across the valley are the sounds of a road being *(Continued on page 139)*

For young women in Thimphu (above), rice farmers in Paro (below), and other Bhutanese, the official measure of well-being is Gross National Happiness. Introduced in 1972 by King Jigme Singye Wangchuck, GNH provides a less materialistic way to measure success than GNP. In Bhutan the pursuit of happiness—and its attainment—are state business.

Demon (and crew member) Sonam Kuku gets bloodied on the set of *Bakchha (A Ghost's Attachment)*. It's a horror film and a musical, says screenwriter Tshering Penjore. "A hit song almost always guarantees success." With 24 releases in 2006, Bhutan's movie industry is rising.

Villagers gather at a water pump in Nimshong, just inside Jigme Singye Wangchuck National Park in the Black Mountains. Electricity and phone service are mostly unavailable here, and the nearest road is a half day's walk away. Such rural isolation is still the rule in Bhutan.

A rough-and-ready school in Jangbi draws 55 children from three villages. In such remote areas, lack of access to schools remains a problem. To increase enrollment, the government, in its last five-year plan, called for more than 120 community schools to be built.

blasted through the forest several miles away. A rotating crew of 15 villagers from Nabji contributes labor, hauling 150-pound bags of plastic explosive up the mountain slopes. The new road won't reach Nabji for another year or two, but when it arrives, electricity, television, and commerce will follow. Some elders worry that Nabji's innocence will be lost. But the younger villagers prefer listening to Karma Jigme, a 26-year-old painter in baggy NBA-style shorts who recently returned to Nabji after five years working in the towns of Paro, Punakha, and Trongsa.

Jigme's tales from the modern world have all the magic of Bhutan's traditional legends. The first time he saw television, he says he hid under his bed, fearing that the angry pro wrestlers on screen "would jump out of the box and hurt me." A bigger shock came when he and his crew were repainting Taktshang Goemba, the famed Tiger's Nest monastery above the Paro Valley. Perched on a plank of scaffolding some 2,500 feet up the cliff face, Jigme heard a deafening roar and then, not 300 yards away, "I saw a house in the shape of a fish flying through the air." The airplane terrified him so much he almost tumbled off the platform.

Life in Nabji brings no such drama. Jigme toils long hours in his family's rice and potato fields, earning extra cash painting traditional scenes on village houses—including, yes, a few thunderbolts. He needs the money to buy an ox. But what he really wants, he says, "is a Nokia." It doesn't matter that, for now, mobile phones don't work in Nabji. He just wants a little piece of the modern world.

TSHEWANG DENDUP OWNS the only denim gho in existence. He also plays a mean air guitar, hangs a Che Guevara poster in his living room, and often wears his hair so long he pulls it back into a ponytail. A rebel in the making? Not quite. Dendup, 38, runs the news department at the government-financed Bhutan Broadcasting Service (BBS), the country's only television station. The son of a weaver and a lay Buddhist priest, Dendup strives to balance tradition and

modernity. "If we only had the old, we'd still be cocooned here, left out of the wider world," Dendup says. "But if we only had the modern, we would have lost our culture. We need both to survive." He's confident that technology and tradition can blend, citing the CD player he bought for his father, who had never seen such a gadget before and who now pulls out the machine to play sermons and chants for his guests.

Cultural vitality resists easy measurement. Is it a zero-sum game, in which every Britney Spears video signifies an irretrievable loss, sending Bhutanese traditions one more step toward extinction? Or is it more like three-dimensional chess, a complex arrangement in which Buddhism and Game Boys can live side by side?

If optimists like Dendup are right, Bhutan's emergence is invigorating local culture. As modern communications spread—28 percent of households now own a television, 11 percent a cell phone, about 3 percent a computer—citizens are connecting with each other as well as the rest of the world. This is no small achievement in Bhutan, whose only cross-country road is so slow, narrow, and sinuous that it takes three days to traverse the 150 miles (as the raven flies) from east to west. Villagers separated by mountains now share the experience of watching their national TV network. New radio stations, such as Kuzoo FM, bring young people together to talk about music, culture, and modernization. In 2006 the king even allowed two independent newspapers to emerge as alternative voices to *Kuensel*, still seen by many as the official mouthpiece.

The local music and film industries have also flowered. Two decades ago Bhutan had never produced a feature film. In 2006 this tiny nation released 24 films, perhaps the highest per capita rate in the world. Is it coincidence, or karma, that the film director leading the way is considered the reincarnation of a 19th-century Buddhist saint? Khyentse Norbu, one of Bhutan's most revered lamas, makes movies that explore the playful encounters of tradition and modernity. He followed his surprise hit about soccer-loving monks, *The Cup* (1999), with a Bhutanese tale, *Travellers and Magicians* (2003), casting the hip journalist Dendup as a restless bureaucrat. "Movies," says Norbu, 47, "are our modern-day *thangkas*"—the ancient Tibetan religious scrolls adorned with colorfully illustrated stories. "Rather than fear modernization," he says, "we should see it as a tool that can help us express our culture more powerfully."

Bhutan's traditionalists, however, see a darker force at play: the invasion by a materialistic global monoculture that is eroding their values. The government has banned channels deemed harmful, including MTV, Fashion TV, and a sports channel that featured violent wrestling spectacles. Sonam Tshewang, a junior-high teacher in Thimphu, believes something vital has already been lost. "Some kids have become so Westernized that they've forgotten their own cultural identity," he says. One girl in his class even changed her name to Britney.

> Peldon, who displays photographs of the kings in her home, has seen the monarchy's benefits. Three years ago a road materialized, cutting the trip to town from days to two hours.

The identity crisis runs deeper than a name change. A cocktail of social pressures is fueling new problems. Youth unemployment is running at about 30 percent in Thimphu, as rural high-school graduates flock to town dreaming of civil-service jobs that fail to materialize. Gangs with names like Virus and Bacteria have formed. Violent crime is still rare, but theft—once absent in a country with few locked doors—is becoming more common, as people covet their neighbors' mobile phones and CD players.

Drug addiction is also on the rise. Near the

entrance to Destiny Club, one of Thimphu's handful of new discos, three young revelers discuss the virtues of "pig's food," a potent variety of marijuana, abundant in the Bhutanese countryside, that is used traditionally as an appetite enhancer for livestock. "Do kids in America also get addicted?" asks the trio's leader, a 23-year-old with reddened eyes. Thimphu's drug scene might seem tame by international standards, but this can hardly be the kind of happiness the king envisioned. Ugyen Dorji, a former addict who founded Bhutan's first drug-rehabilitation center three years ago with the help of the Youth Development Fund, says it reflects "the anxieties of a society in transition."

FOR ALL ITS RUGGED independence, Bhutan is plagued by a sense of vulnerability that comes from being the last bastion of Himalayan Buddhism. The others have vanished, among them Ladakh (dismantled in 1842 and later absorbed into India), Tibet (invaded by China in 1950), and the neighboring kingdom of Sikkim. In 1975, just three years after Jigme Singye Wangchuck took the throne at age 16, a rising tide of Nepali immigrants voted independent Sikkim out of existence, annexing it to India. Was Bhutan next? Wangchuck moved to defend Bhutan's prime asset, its Buddhist identity. "Being a small country, we do not have economic power," he explained to a *New York Times* reporter in 1991. "We do not have military muscle. We cannot play a dominant international role because of our small size and population, and because we are a landlocked country. The only factor…which can strengthen Bhutan's sovereignty and our different identity is the unique culture we have."

A sensible stance, perhaps, but one that set the monarchy on a collision course with the country's largest ethnic group, the Hindu Nepalis. Unlike the ruling Ngalong, or Drukpa, in the northwest and the Sharchop in the east—both Buddhist descendants of Tibetans who settled the country centuries ago—the bulk of Nepalis arrived in Bhutan's mosquito-infested lowlands in the late 1800s and early 1900s. Other waves came after 1960, some invited as manual laborers, others crossing the border illegally. The monarchy encouraged assimilation, but the growing Nepali population alarmed the Drukpa elite. After tightening citizenship laws, the king decreed that all Bhutanese must follow the Drukpa code of dress and conduct. Thus began a cycle of protests and arrests that sent tens of thousands of ethnic Nepalis fleeing across the border between 1990 and 1992.

Govinda Dhimal was one of them. A devout Hindu, he and his family had lived contentedly in the southern district of Tsirang for more than half a century. But the indignities piled up. Dhimal was required to wear a bulky gho, ill-suited for the subtropical heat. A soldier forced him to erase the Hindu markings from his forehead. When Nepali militants organized protest rallies, the army responded with mass arrests—and Dhimal ended up in jail. Weary and broken, the 69-year-old signed a "voluntary migration form" and fled into the unknown. When he reached the border, in early 1992, he hurled his gho back into Bhutanese territory—the last vestige of Drukpa culture imposed on him.

For the past 16 years Dhimal, now 85, has languished in a United Nations camp in eastern Nepal, trapped in one of the world's most intractable refugee crises. The governments of Nepal and Bhutan have held 15 rounds of talks, yet not one of the 108,000 refugees has been allowed to go back. For them, and for many of the ethnic Nepalis still in Bhutan (roughly estimated at 150,000), the monarchy's vigorous promotion of Buddhist culture has been a source of misery.

The overt tensions in the south mostly are gone now. Robust economic growth along with easing cultural restrictions have enabled some Nepalis to build comfortable lives. Many, however, still live on the fringes of society, relegated to manual labor and barred from obtaining business licenses, government jobs, or access to higher education. "We are not treated as equals," says one Nepali engineer in Thimphu. "If my father died, I would not even be able to give him a proper Hindu burial."

Across the mountains, sitting in his dirt-floor

hut in the UN refugee camp, Dhimal still longs to return to Bhutan, though there is little chance of that now. The monarchy has not budged from its refusal to let the refugees back, and an offer by the United States to admit 60,000 of them—though stymied in early 2007 by violent militants demanding a full return to Bhutan—is regaining momentum. Dhimal's grandchildren seem eager to start a new life. "We have no future here," says his 15-year-old grandson, Tek Nath. "I'd like to see what America is like."

Dhimal is unconvinced. "What would I do there?" he asks. "My home is Bhutan."

Now comes the culmination of Bhutan's experiment. Never before has a beloved monarch voluntarily abdicated his throne to give power to the people. But in 2006 King Wangchuck did just that.

REVERENCE FOR ROYALTY runs deep in Bhutan, and few feel it more keenly than a woman named Peldon. She has lived her 41 years in the shadow of the royal family's ancestral home, Dungkhar, a simple timbered house set in a remote northeastern valley encircled by snow-capped peaks. Peldon, who displays eight poster-size photographs of the kings in her home, has seen the monarchy's benefits first-hand. Three years ago a road through the mountains materialized, cutting the trip to the nearest town from two days to two hours. Electricity arrived too, enabling Peldon to attend evening literacy classes and to weave kiras late into the night. "Night has turned into day," she says, "and we owe it all to His Majesty the King."

Now comes the monarchy's most unexpected gift—devolution of power to the people—and Peldon finds it hard to accept. Like many Bhutanese, she wept that day in December 2006 when, after 34 years on the throne, Jigme Singye Wangchuck abdicated in favor of his son, opening the way for parliamentary elections. Peldon reveres the fourth king as a visionary who has led by example, investing in schools and roads rather than palaces and personal bank accounts. His son and successor, Oxford-educated Jigme Khesar Namgyel Wangchuck, arrived in Dungkhar last year to encourage villagers to vote. Peldon admires the young monarch, but the point of the elections eludes her. "We have a good and wise king," she says. "Why do we need democracy?"

Rural peasants aren't the only ones harboring doubts. At a trendy Thimphu nightclub called P. Wang, a trio of power brokers relaxes after a round of golf, singing karaoke and toasting the monarchy. "I don't want democracy, because it can lead to chaos, like in Nepal or India," says Tshering Tobgay, a businessman. "But whatever the king says, we must eat—whether sweet or sour, poisonous or delicious." Even Bhutan's chief election commissioner concedes that he would prefer not to have elections. "Given the choice, of course, we'd want to continue to be guided by the monarchy," Dasho Kunzang Wangdi says. So why change? "It's a simple thing: The king wants it."

The strongest voice for reforming the monarchy, ironically, has been the king's. What would happen, he has argued, if Bhutan fell into the hands of an evil or incompetent ruler? He won the argument—as kings often do—but his stepchild, democracy, has had a few wobbly first steps. Even fielding viable candidates has been a challenge, owing in part to the king's insistence that all aspirants to national office be university graduates—this in a country where less than 2 percent of the people have bachelor's degrees Nevertheless, last summer two top government ministers—Jigme Y. Thinley and Sangay Ngedup—resigned their posts to lead opposing parties into the elections.

Whoever becomes Bhutan's first prime minister this year will likely not deviate from the policy of Gross National Happiness. Ngedup, a jovial former agricultural minister who calls the king's abdication a *(Continued on page 148)*

Afflicted with dengue fever, Tulase and her children, who live in the Samtse district, also face a social hurdle: Although Bhutanese citizens, they are ethnic Nepalis—and stigmatized. So too are tens of thousands of migrant workers, many of them Indians who do the manual labor that Bhutanese citizens often shun, such as building roads (below).

Wending her way through an eastern forest, Kunzang Choden sets off with her nine-month-old baby to visit family. Bhutan's high entry fee for visitors keeps such idyllic places free from crowds of backpackers. Preserving nature is one of the pillars of Gross National Happiness.

In a room he shares with six other monks at a monastery in Wangdi Phodrang, Chencho (at left) is honest about his calling. "It's hard work memorizing all the texts, but afterward you have a comfortable life, so it's worth it," he says. "In the village, work is never ending."

"very Buddhist form of nonattachment," has a special reason to stay the course: As elder brother of all four of the fourth king's wives, he is the new king's uncle. Thinley, for his part, is one of the policy's principal architects and has traveled the globe promoting the happiness gospel. "This idea has captured the imagination of the larger world," Thinley says. "People are searching for a new definition of prosperity."

To survive in democratic politics, Bhutan's next leader will have to make the people happy—and, as the country modernizes, that may hinge on relations with the outside world. Bhutan has forged ties with only 21 countries; the most important is India, which provides military security and buys 80 percent of Bhutan's exports. Most big powers, including the U.S., aren't on the list, Thinley says, "because we wanted to avoid becoming a pawn." The same worry persists as Bhutan moves toward membership in the World Trade Organization. In a globalized economy, no country can fully insulate itself from trade—and, by extension, the WTO. "Our greatest fear," Thinley says, "comes from the unknown."

No such fear plagues Kinzang Norbu, the seven-year-old leader of the B-Boyz. The free-styler may have no conception of free trade or globalization—he is only a second grader—but he imbibes them as easily as he does his own Bhutanese culture. A day after his break-dancing performance, Norbu walks home from school in neatly combed hair, buckled shoes, and a sharply creased gray gho. When he arrives home—a basement bar his mother runs, decorated with photos of Bhutanese monarchs next to a mural of another king, Elvis Presley—Norbu changes into a Diesel T-shirt and discusses, in English, the merits of Allen Iverson and Ronaldinho.

His vote for the world's coolest person? It's a runoff between 50 Cent and Bhutan's fourth king. As a child of Bhutan's great experiment, Norbu sees no need to give up one or the other. Flashing a smile, he says: "I like them both!" □

Birth of a Democracy Photographer Lynsey Addario talks about documenting political change in Bhutan at **ngm.com.**

Hubs of royal and religious authority, *dzongs* like this one in Thimphu have long served as regional arms of the central government. The monarchy may have been fortified by an old Bhutanese proverb: "When there are too many carpenters, the door cannot be erected." Now, as the king relinquishes control, democracy puts those words to the test.

HOW TO HELP

ANIMAL MINDS, PAGE 36

The Thinking Chimp

We may be closer to the apes than we think—when we think. Scientists at the Living Links Center, part of Emory University's Yerkes National Primate Research Center near Atlanta, Georgia, study human evolution and the relation between primate and human behavior by observing resident colonies of chimpanzees, capuchin monkeys, and other primates. Recent research includes work on gestures and language as well as selfishness versus altruism in chimpanzees. "'Living Links' is a play on 'missing links,' since the center works with the closest living relatives of us humans," says Frans de Waal, the center's director. "We want to see how similar we are, but also how different." For more information go to *emory.edu/living_links.*

Georgia is one of the smartest chimps at the Yerkes National Primate Research Center.

PHOTO: VINCENT J. MUSI

world beat

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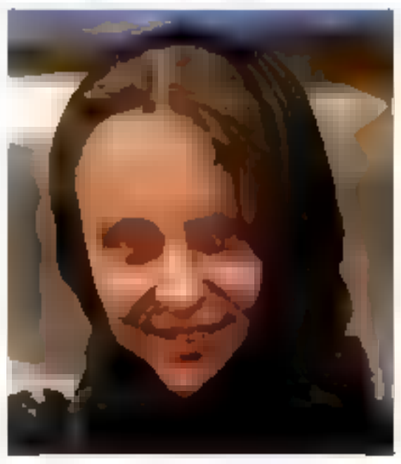
In the days following Saddam Hussein's ouster, Boulat saw Baghdad fall into the hands of looters.



IN MEMORIAM

Alexandra Boulat

Courage without swagger. Talent without arrogance. Alexandra Boulat carried a camera and a fierce concern for ordinary people into ravaged places, recording violence and suffering without ever losing her ability to see decency and dignity. She contributed extraordinary work to the *Geographic* before a brain aneurysm cut the 45-year-old Frenchwoman's life tragically short last year. We will miss her vision and compassion, and remain grateful to have seen the world through her eyes.

Online Tributes Boulat's friends share memories at **ngm.com.**

PHOTOS: ALEXANDRA BOULAT (TOP); JEROME DELAY

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INSIDE GEOGRAPHIC

ON ASSIGNMENT **Danger Dogs** After an evening photographing Iceland's magical landscape under the late-night sun, photographer Jonas Bendiksen (above, at left) and guide Bjarki Reyr were ready for a break. "We were getting hungry and didn't feel like cooking," says Bendiksen—so they plunged hot dogs into one of Iceland's scalding geothermal pools. The smell of sulfur hung in the air, but the Earth-cooked meal, he says, was delicious.

ON ASSIGNMENT

Splashy Swimmers

Photographer Vince Musi met a lot of animals face-to-face for the story on animal minds: "I had nearly every animal poop or pee on my backgrounds, and one of my light stands still smells like marmoset." Musi wasn't allowed in the tank at the National Aquarium in Baltimore—only a few trainers can swim with the dolphins—but he didn't stay dry, either. "They splashed me and tried to destroy all of my equipment."

Baltimore cetaceans strike a pose for Vince Musi.

PHOTOS: JONAS BENDIKSEN (TOP); ANDREW CUTRARO

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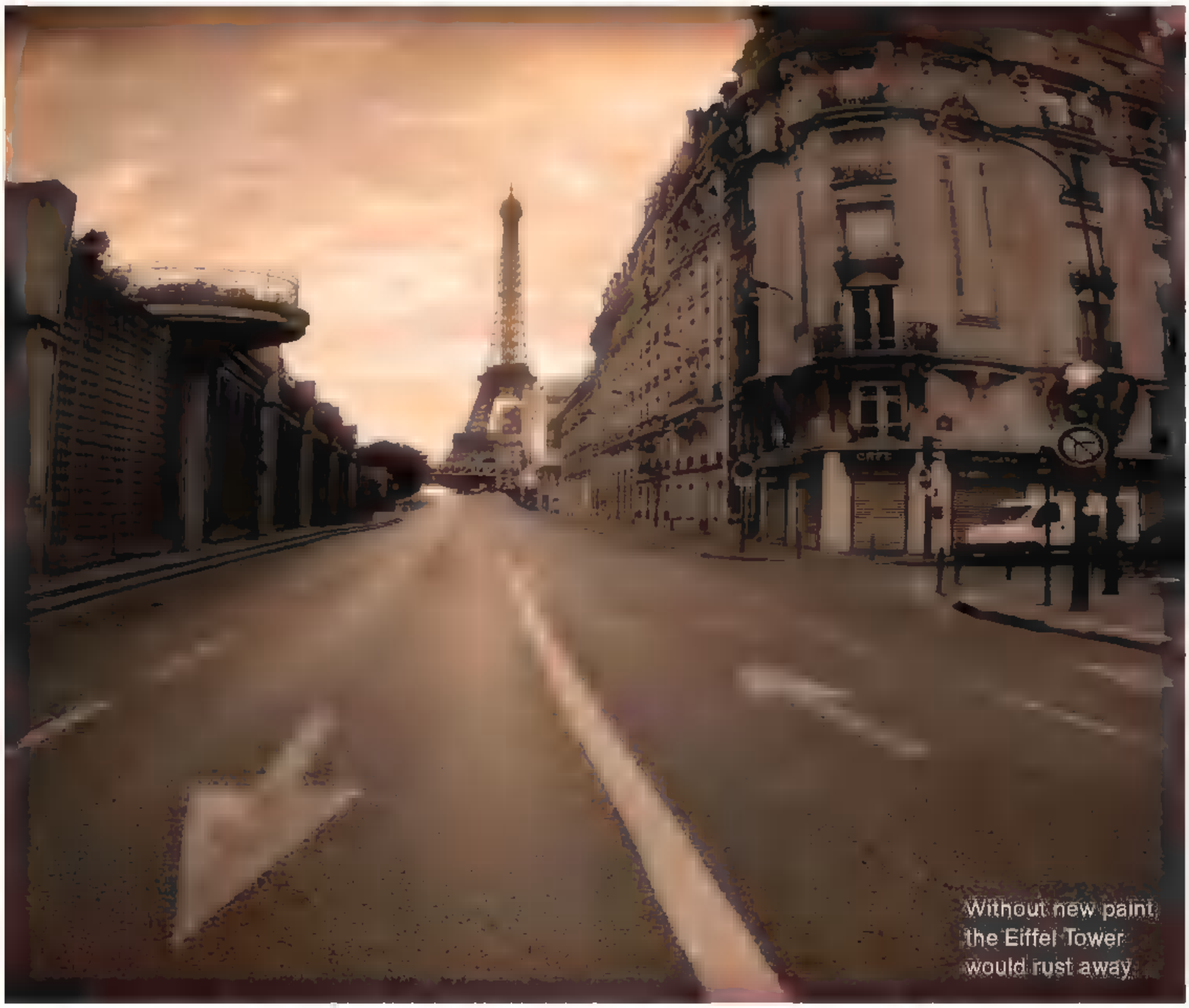

Without new paint, the Eiffel Tower would rust away.

NATIONAL GEOGRAPHIC CHANNEL

After We're Gone *Aftermath: The World Without People,* airing in March, doesn't consider how humans might disappear. Instead, it shows what happens next—illuminating our impact by subtracting us from the picture. Electric fences release zoo animals into the streets, nuclear plants melt down, and, decade by decade, nature reclaims the land.

NG Books

A Camera, Two Kids and a Camel: My Journey in Photographs Photographer Annie Griffiths Belt describes 30 years of photographing for *National Geographic*, often with her children, Lily and Charlie, in tow. They traveled to six continents and spent years in the Middle East, where the children swam in the Red Sea, explored the ancient city of Petra, and, yes, befriended Bedouin and rode their camels. Belt describes encounters with people all over the world, from Pakistani villagers to American cowboys. Among other challenges, Belt survived blizzards, charmed tweedy English mouse fanciers, and went undercover dressed as a man ($35).

PHOTO: DARYL BENSON (TOP)

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FLASHBACK

Sitting Kitty A patient little cat endures lessons in baboonery. According to notes accompanying the photograph—which arrived at the *Geographic* in 1956 but was never published by the magazine—"Baboon mother tries to make Fluffy sit up like a good monkey baby. But the kitten always falls back on her four legs. It seems like such a hopeless case." The baboon, named Helen, was an attraction at Ross Allen's Reptile Institute, a roadside zoo founded in 1929 in Silver Springs, Florida. She may have been a holdover from the days when Tarzan movies were filmed in the region and Allen provided animal actors for visiting Hollywood productions. *—Margaret G. Zackowitz*

Flashback Archive Find all the photos at **ngm.com.**

PHOTO: KURT SEVERIN, NATIONAL GEOGRAPHIC IMAGE COLLECTION

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